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TAIM BILONG BIPO: INVESTIGATIONS TOWARDS A PREHISTORY OF THE
PAPUA - NEW GUINEA HIGHLANDS. (VOLUMES I AND II)

Australian National University (Australia)

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TAIM BILONG BIPO

Investigations towards a prehistory of the
Papua-New Guinea Highlands

J. Peter White

This work is a thesis submitted for the
degree of Doctor of Philosophy in The
Australian National University.

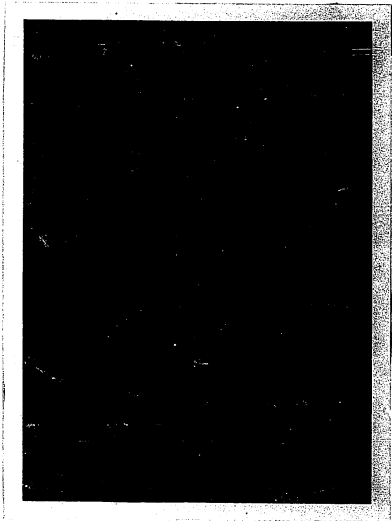
July, 1967

This thesis is the product of field research by the author. In the analysis of some data the help of specialists in various disciplines has been sought and is acknowledged. Apart from this the thesis is my own original work.

A handwritten signature in black ink, reading "J. Peter White". The signature is written in a cursive style with a large, prominent initial "J".

J. Peter White

21 July, 1967



Paintings at Kafivana rockshelter, Asaro valley.
Numbers (l. to r.): 49,50,52,53.
below : 51.

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PREFACE

A great many people in both Papua-New Guinea and Australia have assisted in the work recorded here. In three field seasons and during subsequent study in Australia I have been helped with personal contacts, goodwill and information of all kinds from both laymen and scientists. It would be invidious to attempt to spell out the contributions of individuals and I therefore wish simply to thank the following people and apologise to any whose names have been inadvertently omitted.

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My parents have supported and encouraged me in this
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Two people must be thanked specially for their constant help and encouragement: Jack Golson, who supervised the work with a critical acumen which I did not always appreciate at the time and my wife Carmel who in the midst of her own thesis always found time to discuss this one with me and helped in many more ways.

CHAPTER 1

INTRODUCTION : THE PROBLEM AND THE AREA

Europeans first entered the Central Highlands¹ of Australian New Guinea in the 1930's, but access to this area has been reasonably easy only since World War II. In this period a number of important anthropological studies have been made.²

The prehistoric archaeology of the region remained unknown until Mrs S. Bulmer in 1959-60 surveyed the area from Mt Hagen to Chuave and carried out excavations at the rockshelters of Kiowa (Chuave) and Yuku (Baiyer River). She also found open sites in the form of house depressions, burials, ditches, salt and axe-stone sources.³ The major

¹ Defined approximately as the area of the Eastern, Western and Southern Highlands and the Chimbu Districts.

² For a general account see J.B. Watson, 'Anthropology in the New Guinea Highlands', American Anthropologist, 66 (4), Part 2, 1964, pp.1-19; G. Souter, New Guinea: The Last Unknown, 1963, Chs. 13-14.

³ S. Bulmer, 'Report on Archaeological Fieldwork in the New Guinea Highlands, October 1959 to May 1960', mimeo. (n.d.); S. Bulmer, 'The Prehistory of the Australian New Guinean Highlands', M.A. thesis, University of Auckland, unpublished (1966), Ch. 4.

results of her work were published late in 1964¹ while a definitive excavation report became available in her M.A. thesis in 1967.² Mrs Bulmer's work and the prehistory she and Dr R. Bulmer have written on the basis of it have been of considerable significance in the last few years.

When I started planning a project in 1963 three main fields of study seemed promising:

1. Archaeological research in the coast and foothill areas: the earliest settlements in New Guinea might well be found here while links with northern Australian prehistory might also be apparent. In addition the relationship between the Highlands and coastal and island Melanesia might be studied.
2. Archaeological research in the Highlands to discover
 - (a) How widespread was the industrial tradition discovered by Mrs Bulmer. Did it, for example, extend eastwards from the Mt Hagen-Chuave area into the Asaro valley-

¹ S. Bulmer, 'Prehistoric Stone Implements from the New Guinea Highlands', Oceania, XXXIV, 1964a, pp.246-68; S. Bulmer, 'Radiocarbon Dates from New Guinea', Journal of the Polynesian Society, 73, 1964b, pp.327-8; S. and R. Bulmer, 'The Prehistory of the Australian New Guinea Highlands', American Anthropologist, 66 (4), Part 2, 1964, pp.39-76.

²

S. Bulmer (1966).

Kainantu region which anthropologists,¹ linguists² and serologists³ had seen as different in many ways?

- (b) What ecological and economic information could be discovered about the prehistoric phases of this area. It was suggested that sweet potato at least⁴ and possibly agriculture itself was a recent import.⁵

¹ Notably K.E. Read, 'Cultures of the Central Highlands, New Guinea', Southwestern Journal of Anthropology, 10, 1954, pp.1-43.

² S.A. Wurm, 'New Guinea Languages', Current Anthropology, 2, 1961, pp.114-6 and pers. comm.

³ N.W.G. Macintosh, R.J. Walsh and O. Koopzoff, 'The Blood Groups of the Native Inhabitants of the Western Highlands, New Guinea', Oceania, XXVIII, 1958, pp.173-98.

⁴ D.E. Yen, 'Sweet-potato Variation and Its Relation to Human Migration in the Pacific' in J. Barrau (ed.), Plants and Migrations of Pacific Peoples, B.P. Bishop Museum, 1963, pp.93-118; H.C. Conklin, 'The Oceanian-African Hypothesis and the Sweet Potato' in J. Barrau (ed.), ibid., pp.129-36.

⁵ The papers in which this is best developed were published only in 1965 although the ideas were being discussed some time before. See, for example, F.M. Keesing, 'Research Opportunities in New Guinea', Southwestern Journal of Anthropology, 8, 1952, pp.125-6. The main papers are J.B. Watson, 'From Hunting to Horticulture in the New Guinea Highlands', Ethnology, IV, 1965a, pp.295-309 and J.B. Watson, 'The Significance of a Recent Ecological Change in the Central Highlands of New Guinea', Journal of the Polynesian Society, 74, 1965b, pp.438-50. It is interesting to note that in 1961 the working hypothesis that tuber cultivation was of long standing in the Highlands had been adopted by H.C. Brookfield, 'The Highland Peoples of New Guinea. A Study of Distribution and Localization', Geographical Journal, CXXVII, 1961, p.444.

If this was true and there had been a 'neolithic revolution' in the course of Highlands prehistory this should be perceptible in the archaeological record.

- (c) The cultural and temporal association of mortars, pestles, figurines and clubheads which were found throughout much of Papua and New Guinea.¹ Except for clubheads,² these had not been found either in everyday manufacture and use or in archaeological contexts. Were they the remains of 'stone-using immigrants',³ and if so what other evidence about this group could be found?

3. Ethnographic studies of the manufacture and use of stone tools and other items of material culture in neolithic societies. The work of

¹ For a recent survey of finds see G.L. Pretty, 'Two Stone Pestles from Western Papua and their Relation to Prehistoric Pestles and Mortars from New Guinea', Records of the South Australian Museum, 15, 1965, pp.119-30.

² The making of these is described in B. Blackwood, 'The Technology of a Modern Stone Age People in New Guinea', Pitt Rivers Museum, Occasional Papers in Technology, 3, 1950.

³ Suggested by A. Riesenfeld, The Megalithic Culture of Melanesia, Leiden, 1950, pp.3, 665 and *passim*. This study is of course a recent expression of a long-standing idea. See, e.g., E.W.P. Chinnery, 'Stone-work and Goldfields in British New Guinea', Journal of the Royal Anthropological Institute, 49, 1919, who suggests (pp.286-7) that pestles and mortars are found near goldfields because 'stone-using immigrants' were also gold prospectors.

Blackwood¹ and Salisbury,² among others, showed that these were possible while several archaeologists suggested that they could be of great relevance to prehistoric studies.³ In particular, since Highlands prehistory had ended so recently, technological studies of present Highlands peoples might provide an important guide to the interpretation of archaeological materials there.

The proposal to work in the coast and foothill areas was abandoned following a survey which produced no stratified sites of a pre-pottery, pre-horticultural stone-using type which would presumably be left by the earliest inhabitants⁴ (see Map 1). The relative absence of data of this kind has been noted more recently by Lampert⁵ and although one must agree that this is probably

¹ Blackwood, 1950.

² R.F. Salisbury, From Stone to Steel, 1962.

³ This was strongly drawn to my attention by Professor J. Desmond Clark and Professor F. Bordes in 1962. See also R. Ascher, 'Ethnography for Archaeology: A Case from the Seri Indians', Ethnology, I, 1962, pp.360-9; Grahame Clark, Archaeology and Society, 1957, pp.172-4.

⁴ See J.P. White, 'An Archaeological Survey in Papua-New Guinea', Current Anthropology, 6, 1965b, pp.334-5; D.J. Mulvaney, 'The Pleistocene Colonisation of Australia', Antiquity, 38, 1964, pp.263-7.

⁵ R.J. Lampert, 'Archaeological Reconnaissance in Papua and New Guinea: 1966', A.N.U., Dept. of Anthropology, mimeo. (1966).

due to chance factors,¹ these seemed to be too great for a study so strictly limited by time as my own.

Any proposal to make modern technological studies the main aim of my research program also produced problems. In the absence of written Highlands prehistory it was not clear which observations of stone-using communities could be directly useful to archaeologists. To study these communities in vacuo seemed an inefficient method when the purpose was to obtain archaeologically relevant results. It was also difficult at that stage to pinpoint areas where research of this kind might best be done.

The following chapters therefore describe fieldwork directed towards the problems outlined in Section 2 (above). The search for archaeological sites was directed almost exclusively towards caves and rockshelters since with the Highlands climate and topography these could be expected to record a longer continuous sequence of events than open sites. They should thus provide both a time scale and a general picture of changing technology and economy in the Highlands.

In addition, some ethnographic observations were made once the archaeological material was sufficiently well known to allow some of its problems to be defined. These observations have been used as a basis for part of the analysis of flaked stone tools, which is an attempt at a direct correlation between archaeology and ethnography in this area.

¹ S. Bulmer (1966), p.4.

All ethnographic studies and all but one of the excavated sites lie within the Eastern Highlands and Chimbu Districts, i.e. from the Markham-Ramu fall in the east to the Chimbu valley in the west (see Map 2). The sites occur in an east to west transect across this area and are not concentrated in one region. This has allowed the minor regional variations to be given some expression. It is unfortunate that the two sites (Niobe and Omkombogo) which lie west of the Chuave-Asaro divide¹ have provided so little of the data for this study, but the material was unsuitable for detailed analysis. Fortunately, however, Mrs Bulmer's data is available for comparative studies.

One site is in the Papuan Highlands; this is Kosipe which produced the most important evidence concerning the mortars-and-pestle complex of artefacts (Section 2(c) above) and is therefore included in this discussion.

The synthesis which results from this and other archaeological work in the Highlands can only be brief and tentative at this stage. It may be expanded by drawing on other disciplines, but these too are only in the initial stages of work in this area. One point however is clear: the direct application of ethnographic data to archaeological material may be as fruitful here as anywhere

¹ I propose to follow S. Bulmer (1966), p.13 and make this divide the basis of a division between Eastern and Western Highlands.

in the world¹ and may also, I believe, be of some general relevance to the study of stone-age prehistory.

The geology, climate, flora and fauna of the area are diverse and not yet fully described. A brief general account, however, can be given.²

The terrain of the cordillera is dominated by massive ranges aligned WNW-ESE. Between these and about 5-7,000 ft below them, lie valleys with floors at 4-6,000 ft MSL. Nearly all the present population lives in these valleys at altitudes of less than 7,500 ft. In the main valleys at least, original stands of forest are rare and grassland or secondary growth predominates. In the Kainantu area the

¹ Compare R.A. Gould, 'Archaeology of the Point St. George Site, and Tolowa Prehistory', University of California Publications in Anthropology, 4, 1966; B.M. Fagan and F.L. Van Noten, 'Wooden Implements from the Late Stone Age Sites of Gwisho Hot-springs, Lochinvar, Zambia', Proceedings of the Prehistoric Society, n.s., XXXII, 1966, pp.246-61; L.R. Binford, 'Smudge Pits and Hide Smoking: the Use of Analogy in Archaeological Reasoning', American Antiquity, 32, 1967, pp.1-12; J.P. White, 'Ethno-archaeology in New Guinea: two examples', Mankind (forthcoming).

²

This summary is derived from a number of sources including H.C. Brookfield, 1961; H.C. Brookfield, 'The Ecology of Highland Settlement: Some Suggestions', American Anthropologist, 66 (4), Part 2, 1964, pp.20-38; 'Lands of the Goroka-Mt. Hagen Area, New Guinea', C.S.I.R.O. Division of Land Research and Regional Survey, Divisional Report, 58/1, 1958, Canberra. [Listed in bibliography under C.S.I.R.O.]

country is more rolling than further west and the grasslands are more noticeable. In most of the more heavily populated areas the rainfall is 60-100 inches a year with a drier season in May-August.¹ The marsupial fauna is considerable; much of it is restricted to the forested areas, where the largest mammal is the tree kangaroo, Dendrolagus sp. which weighs under 20 lbs.² The largest bird is the cassowary (Casuaris sp.) which may weigh over 50 lbs. The vegetational resources of the area are also varied, and are potentially able to support hunter-gatherer populations.³ The very high population densities in some areas show that the area is generally very suitable for horticulture.⁴

The sites I excavated in the Highlands all lie on the floors or lower slopes of the valley systems. Batari and Aibura are both within the Upper Lamari R. system, in the gorge cut by the river.⁵ The sites lie at 4-5,000 ft MSL and the valley is grassed up to 6,500 ft or more. Kafiavana is at almost the lowest point in the southern

¹ H.C. Brookfield and D. Hart, 'Rainfall in the Tropical Southwest Pacific', Dept. of Geography, Publication G/3 (1966), A.N.U., Canberra, Maps 6(a)-8(a).

² See Appendix 3.1; also S. and R. Bulmer, 1964, pp.50-1.

³ S. and R. Bulmer, 1964, p.49; R.N.H. Bulmer, 'Edible Seeds and Prehistoric Stone Mortars in the Highlands of East New Guinea', Man, 64, 1964, pp.147-50.

⁴ Brookfield, 1964, pp.25-9.

⁵ D.B. Dow and M.D. Plane, 'The Geology of the Kainantu Goldfields', Bureau of Mineral Resources, Geology and Geophysics, Canberra, Report, 79, 1965.

Asaro valley, at the junction of the Asaro, Dunantina and Fayantina Rivers. It is surrounded by grassland for a considerable distance.¹ Niobe is on the backslope of Mt Elimbari, but the area may be characterised as lying within the Chimbu-Wahgi system : it is today on the fringes of one of the most densely populated areas in the Highlands. Omkombogo, where a test excavation was made, is within the densely populated Chimbu valley.

All the sites are thus well within the altitudinal zone occupied by most Highlands peoples today.² They probably also lie within the zone within which earlier populations lived, since this is normally assumed to lie below about 6,000 ft.³ The sites may therefore be taken as representing to some extent the use of caves and rockshelters throughout the prehistoric period.

¹ 'Lands of the Goroka-Mt. Hagen Area', C.S.I.R.O., 1958.

² Brookfield, 1964, pp.20-4.

³ E.g., S. and R. Bulmer, 1964, p.51.

CHAPTER 2

ARCHAEOLOGICAL SURVEYS AND TEST EXCAVATIONS1. Introduction

In 1963 excavated archaeological sites on the mainland of Papua-New Guinea consisted of:

- (a) a few ceramic-period sites, generally of little depth, in coastal areas¹ and
 - (b) two rockshelters, each containing a stratified series of stone artefacts, and some recent house-mounds in the New Guinea Highlands.²
- There were also reports of axe quarries and salt 'factories' in the Highlands³ and of shell middens, old village sites and caves in coastal areas.⁴

¹ R. Pösch, 'Einige bemerkenswerte Ethnologika aus Neu-Guinea', Mitteilungen der Anthropologischen Gesellschaft in Wien, XXXVII, 1907, pp.67-71. (Translated by Translation Unit, University Library, A.N.U.); F.E. Williams, 'Papuan Petroglyphs', Journal of the Royal Anthropological Institute, 61, 1931, pp.137-8; M.F. Leask, 'Tools of a Canoe-Building Industry from Cape Wom, Northern New Guinea', Oceania, XVII, 1946, pp.300-9; S. Bulmer (1966), pp.2-4 surveys this evidence.

² S. Bulmer, n.d., pp.12-6.

³ Ibid., pp.11-2.

⁴ Messrs N. Oram, H. Niall, H. Morris, W.E. Tomasetti, Dr H. Haantjens, and others, all pers. comm.

From February to April 1964 an 11 man-weeks survey was made by my wife and I in 6 coastal, 3 foothill (1,000-4,000 ft MSL) and one Highlands district to assess the reliability of these reports and to search for stratified sites, especially from a postulated pre-ceramic phase on the coast.¹ The coastal areas included Kairuku-Bereina, Port Moresby and Marshall Lagoon on the southeast coast of Papua, Wanigela and Tufi in Collingwood Bay on the Papuan north coast and Lae in the Huon Gulf. The foothill areas were Sogeri (inland from Port Moresby), Tapini (in Goilala country) and the Snake River (Buangs) valley near Lae. An area around Kainantu in the Highlands was also surveyed (see Map 1).

2. Coast and Foothills

The survey located very few surface finds: this contrasts very strongly with most temperate-climate surveys² and even with those in drier tropical conditions.³ Part of the explanation for this fact must lie in the topography and climate of New Guinea. All the areas we visited were topographically immature, with steeply dissected plateaux, high mountains contorted by tectonic activity and topped with razor-like ridges, or flat marshy river plains where flooding is recurrent and rivers

¹ White, 1965b.

² For example Tasmania: R.M. Jones, pers. comm.

³ For example Northern Australia: Carmel White, D.J. Mulvaney, both pers. comm.

frequently change course. Tectonic activity is still considerable and land-slips frequent. Apart from a small area around Port Moresby the rainfall is usually high (greater than 60" per year¹) and the rate of erosion considerable. Within the hot, wet rain forest the decay of all organic material is very rapid. We visited the sites of villages, occupied within living memory, which are now indistinguishable from the surrounding country except for the presence of occasional sherds and shells. It is worth considering the immense amount of material which had been destroyed in this instance alone, for it contrasts markedly with the preservation of village mounds, which, in Mediterranean-type climates, record events up to 8,000 years ago.²

In this situation our survey concentrated on discovering caves and rock shelters which give some protection from the weather. Evidence in the shelters and caves visited suggests that humans make only occasional visits to most of them and leave few traces. In many areas we were shown shelters which had been used for refuge during World War II or pre-European fighting, but in very few of them could any trace of this recent use be located.

After examining 39 caves and shelters which were worth recording, and visiting perhaps as many again, we

¹ Brookfield and Hart, 1966, map 5.

² See for example, R.J. Rodden, 'Excavations at the Early Neolithic Site at Nea Nikomedeia, Greek Macedonia (1961 Season)', Proceedings of the Prehistoric Society, n.s., XXVIII, 1962, pp.267-88.

found two sites which might repay further excavation. Kukuba, on Ou Ou Creek, could provide a dated record of Mekeo ceramics and environmental exploitation in the northern Central District; Miagolo III could yield some ecological information about people living near the sea in the southern Central District. It may be that these sites will be mostly useful in relation to problems of recent prehistory. We also located five new art-sites in the Sogeri region.

The methods used on this survey differ from those used in temperate climates or lightly populated areas. Because vegetation is too thick to see shelters from afar we used local people, who knew the area well, to take us to any caves they knew of. Some reports could be ignored, but it was found that in each new area some fruitless journeys had to be made before local understanding was reached. In addition, because of lack of interest by Europeans in the natural environment and the rarity of detailed geological studies, it was very difficult to assess even the general archaeological potential of an area without visiting it.

This survey did not produce sites containing a stratified series of stone artefacts, nor any good evidence of long-term occupation. This pattern was found subsequently by Lampert in other coastal areas,¹ so that two fairly lengthy surveys have now failed to reveal the type of sites necessary to answer questions about the earlier coastal settlers. It is possible that such sites

¹
R.J. Lampert (1966).

do not exist; but it is more likely that they are still hidden in the jungle.

1) Port Moresby

The Central District around Port Moresby is one of the most accessible regions in the Territory.¹ The rainfall is comparatively low along the coast (40"-60" p.a.) and there is a reasonable road network. The country has a 5-15 mile wide stretch of savannah vegetation along the coast while lowland rain forest becomes dominant inland. The coastal topography consists of low rolling hills and river flats. From Port Moresby these continue north and west for about 25 miles. About 10 miles east of the town and about 10 miles inland rise the Astrolabe Ranges. The Sogeri region lies between these and the Owen Stanley Ranges, at an altitude of 1,000-3,000 ft. The surface geology of the Sogeri region is dominated by a Pliocene volcanic agglomerate with inter-bedded tuff, now steeply dissected by the Laloki River and its tributaries. The western edge of the agglomerate forms a long scarp.

Most of the area surveyed was in the Sogeri district, 20-40 miles north-east of Port Moresby. Surveys were also made along the coast for about 10 miles to the west (Porebada village) and for about 40 miles to the east (Kapakapa village). Some work was done on the upper

¹

For detailed description of geology, climate, soils and vegetation see J.A. Mabbutt et al., 'Lands of the Port Moresby-Kairuku Area, Territory of Papua and New Guinea', Land Research Series, 14, C.S.I.R.O., Melbourne, 1965.

Hiwick and Musgrave Rivers. We did not have time to survey in the Brown and Vanapa River valleys.

Three types of sites were reported in the Moresby area. These were:

- (1) shell middens along the coast
- (2) deserted village sites
- (3) rock shelters and caves with paintings and engravings in the Sogeri district.

(1) Shell middens.¹

Most of the sites reported to us as being shell middens, and most of those we discovered, were surface sites, without any depth of deposit. Both on the coast and in the low hills near the coast, surface scatters of shell occur (max. 1 shell/sq. foot) associated with occasional sherds and chert flakes. On the hill sites these finds rest on the 3-10 cm. of soil which covers the bedrock (e.g. Hohola, Steamships Quarry Hill). On the coast we found no surface indications which led to a deeper deposit.

Two sites with about 30 cm. of shell deposit were recorded, both being closely associated with a modern village. Surface finds included shell, sherds and occasional chert flakes. A test excavation at Pari produced chert flakes, sherds and bone from a shell midden

¹ See Lampert (1966), pp.1-2.

some 35cm. deep. The sherds all seem to be of modern Motu pottery.¹

(2) Deserted villages.

A large number of deserted villages are known from the Sogeri area, where they are being mapped by Patrol Officer H. Morris.² Sites of this type were also reported to exist in the Brown and Vanapa River areas to the north of Sogeri, and in the Hood Peninsula.³ Most of these villages were occupied within the last two or three generations - at a maximum perhaps 100 years ago.

Inland villages in this region are usually built on ridge-tops. The heavy rainfall and consequent erosion of the steep topography combined with rapid vegetation regeneration all combine to ensure that nearly all traces of occupation are rapidly removed when a village is abandoned. Although surface scatters of sherds could be collected and occasional stone fireplace circles were seen, this applied largely to villages abandoned within the last 30 years. Older sites are now only recognisable by patches of secondary forest. We found no village mounds where a depth of deposit could be observed.

¹

No study has yet been made of Motu pottery decoration, but the pottery was like that seen in Motu villages. Motu pottery manufacture is described by M. Groves, 'Motu Pottery', Journal of the Polynesian Society, 69, 1960, pp.3-22.

²

See also 'Brown River Crown Lands', File 35-11-24, Folio 21, Dept of Lands, Port Moresby.

³

N. Oram, New Guinea Research Unit, A.N.U., pers. comm.; Lampert (1966), pp.1-2.

(3) Rock shelters and caves.

a. Rock shelters (Map 3)

Rock shelters are common in the Sogeri region, and are formed in two ways:

- (1) by the erosion of the tuff bands, up to 12m. thick, which occur within the main sheet of agglomerate,
- (2) under the lee of large blocks of agglomerate which have broken away from the main sheet.

Of the sites we recorded 11 were of type (1) (Sakurukuru, shelters near Wureva, Moro, Oma, Koba, Yoi, Waru, Moka, Ramadordo, Jawarere shelter¹), and 9 of type (2) (Itikinumu 1 and 2, Ver 1 and 2, Wureva, Toboalogo, Ifa Kuruku, Wakuia Wai, Vefai). Moreover, of the 20 shelters recorded, 10 were painted or engraved. Of these 10, the art in 5 had already been partly recorded.²

Surface finds were rare. Test trenches were made in two shelters and the nature of the deposit investigated in 16 others. The remaining two were without deposit of any kind. Some finds were made, particularly at Koba, but no stratified deposit was evident at any shelter.

¹

This shelter lies several miles further east, off the map.

²

W.M. Strong, 'Rock Paintings from Papua', Man, 23, 1923, pp.185-6; W.M. Strong, 'More Rock Paintings from Papua', Man, 24, 1924, pp.97-9; Williams, 1931, pp.124-9, 135, 138, 141-54; M.F. Leask, 'Rock Engravings and Paintings of the Sogeri District of Papua', Mankind, 3, 1943, pp.116-9.

(i) Paintings and Engravings

The five sites from which paintings and engravings have already been published are Wureva, Ifa Kuruku, Oma, Yoi and Wakuia Wai. At Ifa Kuruku and Wakuia Wai we recorded some paintings and engravings not published in detail (Plates 2-1, 2-2).

Five sites were located where the art had not been recorded. These were Ramadordo, Ver 1, Moka, Vefai and Sakurukuru¹ (see map 3). The art at these new sites is very similar to that already described, but some new forms were found.² (See Appendix 2.1 for full list).

The art at these sites consists largely of engravings. The most common forms are

- (a) a circle, oval or lemon shape, often with an engraved vertical line or dot at the centre, and
- (b) an M shape, joined across the base, the whole often inverted to a W shape. This symbol is also sometimes found with an engraved vertical line or dot in the centre.

¹ J.P. White and C. White, 'A New Frontier in Archaeology: Rock Art in Papua-New Guinea', Illustrated London News, 245, 14 November, 1964, pp.775-7. Some illustrations of the sites of Vefai and Sakurukuru have recently been published, but were 'discovered' after our survey: see F. Kleckham, 'Previously Unrecorded Rock Carvings in the Sogeri Area, Papua', Transactions of the Papua-New Guinea Scientific Society, 7, 1966, pp.12-6.

² Some of our films were unfortunately lost in the mail so that our photographic coverage is incomplete.

At some sites some of these designs were painted in red. The engraving is produced by pecking, perhaps followed by a final polishing in some cases. This results in a deep, smoothly U-shaped groove. At one of the new sites (Ramadoro) we found some engravings made with the scratch technique employed at Yoi and Wakuia Wai.

We cannot at present date this art. The local Koiari people say that they did not make it and they have no legends concerning it. Given the exposed condition of some of the engravings and paintings and their good state of preservation, we do not think it can be very old.

The interpretation of this art in detail still remains as a work for the future, when all figures have been accurately recorded, the superpositions studied and a detailed anthropological investigation made in the area. There are, however, some points of interest to be noted.

Whereas nearly all of the engravings can be fitted into one stylistic tradition, the variations between the painted sites is much greater. For example, the semi-naturalistic monochrome figures from Yoi are not repeated among the complex, abstract, polychrome designs of Ifa Kuruku. It seems unlikely that this connotes a greater time span for the paintings as opposed to the engravings as the former would weather more quickly; it is more likely that the engravings and the paintings were created for two different purposes, and that the artistic styles of the paintings changed more quickly.

A similar design to the barred oval (a) above is found among the engravings of central Queensland and

western New South Wales.¹ In the designs of this area the central bar tends to be more pronounced both in depth and width than in the Sogeri designs, but in size and possibly technique, they seem to be alike. I do not wish to suggest that there is any necessary connection between the two areas: in neither case has the art been dated, nor do we know the meanings it carried for its creators, so that to do more than record the similarity would be premature. In no intervening region has art of this type been located.²

Our local informants suggested that these designs might represent vulvar symbols and be connected with initiation ceremonies.³ This meaning has been attributed to similar designs in the prehistoric art of other areas,⁴ but our information may be unreliable since the Koiari people also claimed to know nothing about the creation of this art.

It is interesting to find that the transcripts and photographs we have made show some variations from those

¹ A.P. Elkin, 'The Origin and Interpretation of Petroglyphs in Australia', *Oceania*, XX, 1950, pp.142-5. (I owe this reference to Dr D. Tugby).

² I am grateful to Mr R. Wright, Department of Anthropology, University of Sydney, for discussing this with me.

³ Mr T. Dutton, Dept. of Anthropology, A.N.U., who has been carrying out linguistic studies in the area, was told that they represent okari nuts which formed an important part of the traditional diet of the Koiari people.

⁴ P. Graziosi, *Palaeolithic Art*, 1960, Pl. 118.

made by Williams in 1930. Williams, Plate XIV(4) shows a man from Wakuia Wai with one leg engraved as a single line while the other is formed by two lines forming a V at the foot: our photograph of the same engraving shows two single-line legs with genitals between them.

(ii) Industries and Excavations

Surveys of surface material were made at the shelter sites and in all cases the finds were of recent date, consisting of pottery sherds, bone and shell. These finds were left on the sites.

In order to assess the archaeological potential of the sites two trenches were dug at Ifa Kuruku and one at Koba. At other sites small holes, similar to those made by a 4 inch auger, were made to varying depths. Finds included potsherds, axes and ochres, as well as shell, bone and vegetable remains, but no stratified sites were found. The excavations are described in Appendix 2.1.

b. Caves

The only caves seen were at Jawarere on the Musgrave River, part of the Kemp Welsh River system to the east of the Laloki system. These caves are formed by underground streams in limestone. The geological formation is largely perpendicular weathered pinnacles so that the entrances are down steep slopes into caves which are full of water. They are totally unsuited for human occupation now, and no traces of human use in the past were observed.

2) Yule Island¹

During a survey lasting one week on Yule Island and the adjacent coast near Geabada village and Ou Ou Creek we located one cave suitable for further excavation.

Yule Island lies 60 miles north-west of Port Moresby and some 2 miles off the coast. A guano cave had been mined there some 10 years previously and although no bones or archaeological material had been noted during the excavation, we thought that it might be worthwhile investigating. Unfortunately the 'cave' proved to be a narrow fissure on the beach which ran directly into the hill and widened out into a small chamber. It seemed unsuitable for human occupation and indeed no traces were found.

Ou Ou Creek is a small creek some 6 miles south-east from Yule Island. About 4 miles from the mouth of this creek is a hill about 30m. high, which is riddled by a large cave system presumably formed by water action on the limestone. The cave, called Kukuba, was mined for guano a few years ago, but unlike the Yule Island cave it yielded pottery and several human skeletons. A test excavation revealed a stratified series of charcoal, ash and guano deposits, containing large quantities of pottery, along with a few fragments of bone and chert.

The present owners of the cave, the people of Oroï village, identified the pottery as being of the type made today and, moreover, claimed that they had used the cave as a refuge during the Mekeo wars some 50 years ago.

¹ Survey by Carmel White.

This site will probably yield valuable information to a ceramic specialist and there is no evidence so far of a pre-pottery phase at the base. As it is one of the very few stratified sites found in Papua, it would be foolish to remove the overlying level in the hopes of finding pre-pottery material, without having on hand someone to study the pottery.¹

This cave presents several practical problems to the would-be excavator. In spite of the size of the entrance the cave is rather dark, since the slope of the entrance blocks out a good deal of light. Pressure lamps and reflecting screens would be needed for an efficient excavation. There are also some 20-30cm. of fresh guano overlying the stratified levels. This guano tends to weigh heavily on the sides of a trench and make it collapse suddenly, so that for this reason as well as for reasons of health, all the guano would have to be removed before excavation commenced. The owner of Ou Ou plantation has expressed enthusiasm at the prospect of being allowed to remove this material.

3) Bereina²

A survey of 6 days was made near Bereina. European residents reported caves in the nearby Weima Hills, but the local people denied that any existed. A burial cave

¹

The pottery from the test excavation is now in Dept. of Anthropology, A.N.U.

²

Survey by Carmel White.

exists at Inawaia village, but for religious reasons its owners refused to allow us entrance to it.

The whole area, apart from the hills, is very flat and dominated by many large rivers. These rivers have changed course many times even within the last few years, and this has probably helped to erase any village mounds which might have built up in this area.

4) Tapini¹

Tapini lies about 80 miles north of Port Moresby, at an altitude of 3,300 ft, on the edge of the Papuan Highland chain proper. Three caves were visited which local villagers said were inhabited long ago. They contained only a few centimetres of modern ash.

5) Marshall Lagoon²

Marshall Lagoon lies about 100 miles south-east of Port Moresby. It is about 6 miles long with a narrow entrance to the sea. There were several reports of caves and a promising limestone outcrop in this area. I spent three days investigating caves on Miagolo Hill 6 miles north-east of the head of the lagoon and a further three days at Kiagolo, about 8 miles north-west of Marshall Lagoon settlement and about 5 miles from the sea.

¹ Survey by Carmel White.

² This and following surveys by J.P. White except where the contrary is indicated.

The actual coast is very flat, largely estuarine, but at the southern entrance to Marshall Lagoon there is what appears to be a fossil sand dune. Sand dunes do not form in the area under the present climatic conditions, and this fossil dune might therefore be worth investigating as evidence of former climate. There was no time to determine whether the dune contained archaeological remains.

The topography of the area north and east of Marshall Lagoon consists of low limestone hills which form a 20-25 mile wide band of foothills between the sea and the Owen Stanley Ranges. The vegetation is rain forest, except for rare cleared garden patches. Away from the coast the area is only sparsely populated.

Miagolo Hill, 1,200 ft high, is the highest of the local hills. Although some bluffs occur in the limestone, I saw none more than 7m. high, and the limestone of this area does not seem to erode sufficiently irregularly to form rock shelters. The caves which do occur are endogene caves, formed by underground streams dissolving their way through the limestone. One cave seen was formed by dissolution cavity being exposed to the air through the weathering of the cliff face behind which it had formed.

Four caves were investigated. Three of them have no archaeological potential, the entrances being steep (2), wet (2), or very narrow (1). Miagolo III, however, contains some dry deposit. Two test trenches produced burnt bone, shell and carbon, but no implements were found. Details are given in Appendix 2.1.

The cave at Kiagolo contained only a few centimetres of modern ash.

6) Collingwood Bay

A visit of two weeks was made to Wanigela and Tufi in Collingwood Bay. Several 1.0-1.6m deep stratified village sites had been reported at Wanigela¹ and this was one of the few definite reports of this type of site made in the Territory. The Tufi area, about 20 miles north of Wanigela, was reported to contain caves.

The coast at Wanigela consists of a flat, narrow sand bar, separating the sea from a mile or more of mangrove swamp. The present villages are all built on the sand bar, which has been shifted inland by marine action in the recent past.

My impression is that the sand bar, now only 30-100m. wide, used to be much wider; certainly the shoreline has moved inland as much as 10m. in the last 20 years. I was able to locate only two old village sites in the 10 miles of coastline surveyed. One site, which in Pösch's day was 1.5m. thick and stratified,² is now a low unstratified mound, with a maximum height of only 60 cm. above the watertable. A series of trenches produced pottery similar to that found in 1907.³ About 8 miles to the south of this site I was told of small caves in a coastal hill, but was unable to visit them.

¹ Pösch, 1907, pp.67-71.

² Pösch, 1907, p.68.

³ A detailed descriptive study of pottery from this area is being prepared by Mr P. Lauer, Dept. of Anthropology, A.N.U.

Cape Nelson, on the east side of which Tufi is situated, is a 5,000 ft high isolated volcanic outcrop, about 20 miles in diameter. The country rock of the Cape is a volcanic agglomerate, heavily dissected by steep valleys. The coastline is made up of a large number of fjords, some several miles long. Three fjords and some of the valleys leading to them were explored and a number of small shelters found. These shelters are apparently formed by both mechanical and chemical weathering of the agglomerate, and appear to be still forming today. Most of the shelters are small and shallow, the largest being about the size of a large room. Only five contained more than a few inches of soil (see Appendix 2.1).

7) Snake River Valley

The Snake River valley, or Buangs valley, lies to the south of Lae. The river, rising in a valley near the coast, flows south-west away from the coast to join the Bulolo River at Mumeng. The lower half of this valley is a steeply cut limestone gorge. At the upstream end of this, actually on the Ranguai R. about one mile from its junction with the Snake R., lies the Mapos burial ground (Pavelingune), where at least 100 flexed skeletons have been placed in niches in a limestone cliff. In several places skeletons have been piled into mounds several feet high. On the limestone around the skeletons are many red paintings, mostly of human figures and 'Iron Crosses'. They date probably to within the last 150 years.¹

¹ F. Girard, 'Les peintures Rupestres Buang', Journal de la Société des Oceanistes, 13, 1957, pp-5-49.

There are two caves nearby. One is several hundred yards long, but is very wet and dark with an extremely narrow entrance. The other (Awaridu) lies about 60m. above the river and measures 6 x 8m. It is dry, but the floor contains no archaeological remains other than the remnants of recent fires. On the walls are a few charcoal drawings, recently made by children according to the village people. According to all informants there are no other caves in the valley.

3. Highlands

1) Introduction

In April 1964 a survey of two weeks was made in the area around Kainantu. Promising reports of the archaeological potential of this area were received from Dr L. Brass,¹ Professor J.B. Watson² and Department of Native Affairs³ personnel. In the absence of any significant discoveries in coastal and foothill areas surveyed, we felt that a limited survey of the Highlands area should be made for purposes of assessment and comparison.

The headwaters of three great Territory river systems - the east-flowing Markham, the northwest-flowing

¹ Archbold Expeditions, American Museum of Natural History.

² Department of Anthropology, University of Washington.

³ Now Department of District Administration.

Ramu, and the south-flowing Lamari-Purari (Map 2) lie close to Kainantu. These three rivers all provide possible routes by which people might have come into the Highlands from the coast, and their use in this way has been theorised on other grounds.¹ Any archaeological work in this area might therefore throw light on some of the problems of Highland migrations. Moreover, a survey of the recent prehistory of this area would allow comparisons to be made between our results and those of the anthropologists, linguists, and physical anthropologists of the University of Washington Microevolution Project.²

The country around Kainantu lies between 4,500 ft and 7,000 ft and much of it is, by New Guinea standards, rolling rather than steep. Unlike the coastal regions surveyed there are large areas of grasslands, possibly anthropogenic,³ where some exploration is possible without constant reliance on local guides.

¹ R.G. Robbins, 'Correlations of Plant Patterns and Population Migrations into the Australian New Guinea Highlands' in J. Barrau (ed.), Plants and Migrations of Pacific Peoples, B.P. Bishop Museum, Honolulu, 1963a, pp.45-59.

² J.B. Watson, 'A Microevolution Study in New Guinea', Journal of the Polynesian Society, 72, 1963, pp.188-92.

³ R.G. Robbins, 'The Anthropogenic Grasslands of Papua and New Guinea' in Symposium on the Impact of Man on Humid Tropics Vegetation, UNESCO, Djakarta, 1963b, pp.313-29.

The geology of the area is complicated and only part of the region has been studied in any detail.¹ There are numerous beds of limestone, some quite wide and deep, and it is in these that caves and shelters are generally found. The caves range in size from small overhangs to large underground river systems.

Some caves and shelters with archaeological potential were located in the Lamari R. valley, especially south of Obura. A few other sites of limited value were also found.

Following this reconnaissance sporadic surveys were made throughout the Eastern Highlands Administrative District over the next year. Investigations were made mostly on the basis of information received² so that coverage within the District was patchy.

In the Chuave-Chimbu area, especially along the backslopes of Mt Elimbari and the Poral range, a number of caves and shelters with archaeological deposit were located. They are mostly listed in Appendix 2.1, but an account of the main test excavation is included here.

1

N.J. McMillan and E.J. Malone, 'The Geology of the Eastern Central Highlands of New Guinea', Bureau of Mineral Resources, Geology, and Geophysics, Canberra, Report, 48, 1960; Dow and Plane, 1965.

2

This information was gained partly from the many replies to a circular which was sent to all D.N.A. personnel in the Highlands Districts. The circular asked for detailed information about any caves that they knew, and also asked for any information about prehistoric finds. The co-operation received made the task of surveying much easier.

2) Lamari R. Valley

Six sites were discovered between the headwaters of the Lamari and Himarata village.¹ Test trenches were dug in four, the other two being without deposit. Two of these sites (Aibura and Batari) were later excavated more fully and the test trench material is incorporated there.

Five of the sites are painted, four with red and yellow designs and one (Aibura) with white clay pictures.² Negative and positive handprints in red are common (see Appendix 9.1).

3) Chuave

Many shelters and caves were noted in the Chimbu limestone,³ along the backslopes of Mt Elimbari. One of these, Niobe, was later excavated and another, Kiowa, had been excavated previously.⁴ No other sites with more than a few centimetres of archaeological remains were recorded, but such sites almost certainly exist. Many overhangs are painted (see Ch. 9).

¹

Five of these sites were discovered while on a three day patrol with Mr P.J. Thomas of Obura Patrol Post. His willingness to assist my work on this and other occasions is much appreciated.

²

See White and White, 1964.

³

F.K. Rickwood, 'The Geology of the Western Highlands of New Guinea', Journal of the Geological Society of Australia, 2, 1955, Plate 1.

⁴

S. Bulmer, n.d.; 1964a; 1964b, (1966).

4) Chimbu

Many shelters and caves were noted in the Chimbu limestone¹ belts along the Kwi and Singga R. valleys. One promising site (Omkombogo) was discovered on the Singga and a test excavation was made. Test trenches were also dug at two sites on the Kwi. Many of these sites seem to record the recent prehistory of the area and none of them contain large numbers of stone artefacts. The excavation at Omkombogo is reported here and other sites are listed in Appendix 2.1.

Omkombogo²

This rockshelter lies on the right bank of the Singga River, about 3/4 mile upstream from the Gembogl bridge, at an altitude of c.5,550 ft MSL (Map 2). The site is at the foot of a 60m. high limestone cliff and only 5m. above an underground river which rises into the Singga only a few metres to the north. The oval area of dry ground is about 110 sq. metres. It faces east, down river. The site is now surrounded with secondary bush, with gardens and coffee growing only 50 yards away (Figure 2.1).

Surface remains included ash and a cooking pit. The back wall is heavily blackened with soot. A few red ochre paintings at the north end were made within the memory of local people.

¹ Rickwood, 1955, Plate 1.

² Reference number OK64.

An excavation of 2 x 1m. was dug to a maximum depth of 2.5m. Bedrock was not reached and lies at least 30 cm. below this. The excavation was too restricted to allow layers to be carefully dissected, but spits were dug in general conformity with the layering. Figure 2.3 shows the spit levels of the west face and the finds are related to the spits in which they occurred (Tables 2.1, 2.2).

The stratigraphy was generally complex with many thin layers that tend to slope slightly towards the river (Figure 2.2). The upper 30cm. was a confused mixture of white ash, carbon and unburnt vegetable matter, mostly leaves and grass. Below this were many thin layers of ash and carbon in grey, cream and brown silts. At 140-160/180 cm. below surface lay the first of two almost sterile, carbon-free, yellow silty levels, the other of which lay at 210-230 cm. below surface. Between the two was a series of thin dark brown and grey carboniferous silts while a fine grey silt with carbons underlay the lower yellow level. The deposit was highly alkaline throughout, with a field pH of 8-8.5.

The large amount of carbonaceous material in this deposit is evidence of frequent human occupation. The yellow layers and some patches of sand appear to be water-lain as they show signs of bedding and have a well defined and smooth upper surface. Local people say that in the wet season the underground river may flow out from under the back wall of the shelter, but such a phenomenon would probably erode the site. This may have occurred in the past, but clearly it has not happened recently.

A total of 74 post holes were recorded, mostly at 50-60 cm. and 110-122 cm. below surface (Figures 2.4, 2.5). In several places lines of post holes could be seen. Local informants maintained that brush fences, shelters or other structures had never been erected in this site.

Although the site appears to have been heavily occupied, relatively little cultural material was recovered from it (Table 2.1). The top 60 cm. contained almost no stone or animal bone and the deposit possibly results from sporadic, short-term use as a cooking and gardening shelter. Below this very few flaked tools and the remains of at least 59 wild animals¹ were found (Table 2.2). Ground stone tools occurred down to at least 2 metres, while marine or freshwater shell was found throughout. Carbonised Planchonella² seeds also occurred throughout most of the site. Six human teeth and two post-cranial bones were found at 130-160 cm. below surface.

1

Calculated on a within square and within spit basis, on the mandibles and maxillae, except for Zaglossus sp. which is identified by a spine. See Chapter 3 for a discussion of the methods of faunal analysis.

2

Identified by Mr R. Pullen, Herbarium of the Division of Land Research, C.S.I.R.O.

(1) Ground stone

Only two of the twelve fragments are more than flat chips with grinding on one face.

I/(12)¹ is a small fragment containing about 1 cm. of ground cutting edge. The angle of the edge is 65° and there are small use-chips along it.

I/(14) is the butt of oval-lenticular cross-sectioned axe, made in green hornfels. The butt is rounded in plan (3.3 x 3.8 x 1.8 cm.).

(2) Bone tools

All bone tools recovered appear to be broken. They include two points and one slightly spatulate tool. There are also four fragments with highly polished edges.

I/(15). A cylindrical point made from a section of long bone. The tip is fine but not very sharp and the end is broken. Length 7.8 cm., cross-section at end 6.5 x 3.5 mm.

I/(10). Oval cross-sectioned point, broken at the end. Length 2.7 cm., cross-section at end 4 x 2.5 mm.

II/(8). A piece of long bone shaft with one end rounded and ground slightly flat. Width 1.1 cm., thickness 2.5 mm.

¹ Square/spit number.

(3) Flaked stone

Only eight pieces of stone showing traces of retouch or use were recovered. One (II/(13)) is a trimming flake. Two (I/(10) and II/(10)) show some light step flaking, while the rest simply show traces of use-wear.

There is no indication as to the age of this site yet. The lack of local knowledge of posts in the site would imply that the deposit at about 40 cm. down was at least 60 years or so old. Taking this as a minimum and the rate of accumulation to be constant, the site should be at least 400 years old at the base. A maximum age is probably at least several thousand years.

One of the main problems raised by this site is the almost complete absence of flaked stone tools and waste flakes. The absence of cherts and other suitable raw materials in the Singga River may partly account for this as may the suggestion that all occupation is fairly recent. In addition, it is possible that man's activities in this shelter were largely of a specialised kind, such as cooking, which did not require stone tools to be used. This explanation has already been used in regard to some levels of the Yuku site.¹ The amount of flaked stone is too low at Omkombogo to suggest simply that the test trench was dug in the wrong part of the site for finding knapped stone.

¹ S. Bulmer (1966), pp.134-5.

Table 2.1. Osteological excavated material

Sp. Unit	Crown stone	Flaked tools	Waste Flakes	Worked bone	Number of P.M. shells	Small shell	Bird bone	Eggs/shell	Other	Weight (in gms) (Total weight)	Plant remains seeds	Human teeth	Human bone	Shell fragments
I	1									-				
	2			2						0.5				
	3	1		1						-				
	4			1						0.3				
	5						1			0.1				
	6									12.1				
	7									8.6				
	8		1	1			2	1		24.5				
	9						2	2		21.9				
	10		1		1		3			15.0				
	11		1							12.3				
	12	1	1	1						1.9				
	13			1			3			29.8				
	14	2	1	7	2		1	2		56.4				
	15			2	1		2	1		19.7				
	16					1				27.6				
	17			5			3			79.6				
	18					1				6.0				
II	1	71		1						3.9				
	2									6.2				
	3	1								3.3				
	4			3			4			20.7				
	5						1			14.2				
	6						2			14.3				
	7				1		1			12.0				
	8	1	1	1	1					3.9				
	9	2			1		1			5.8				
	10	1	1		3		3			52.2				
	11			3			2			36.8				
	12			4						41.4				
	13	1	1											
TOTALS		12	7	33	8	9	5	20	1	522.1	27	6	2	1

Table 2.2. Oshana: Minimum number of animals
collected within each square and split

Square	Split	Macropods		Cuscus	Pseudochirops	Pseudochirus	Bandicoot	Bat	Reptiles	Large Birds	Small Birds	Unidentified	Total
		A	J										
I	8	2		1	1			1		1			7
	9			1			1						2
	10							1					1
	11			1				1				1	3
	12									1			1
	13		1					1					2
	14	1		1				1		1		1	5
	15	1											1
	16		1		1	1	1	1	1				2
	17	2			1			2	1				2
18							1					1	
II	3										1		1
	4											1	1
	5							1					1
	6	1		1				1					2
	7			1				1					2
	8											2	2
	9						1						1
	10								1	1	3	1	5
	11												1
	12					1						1	1
13	1				1						1	3	
TOTAL		8	2	7	4	1	4	8	1	3	5	14	59

5) Conclusion

In 1964 when I discussed the results of the first season's survey I pointed out that the Highlands was clearly the area in which work should start.¹ Later results and further surveys seem to me to lead to the same conclusion. It is apparent that in many parts of the Highlands archaeological sites of all types are reasonably common. During the last three years, for instance, open sites have been reported throughout the cordillera, from Waitape² through the Wahgi valley³ to Telefomin.⁴ More shelter sites and rock paintings have also been found in the Eastern and Western Highlands Districts. There are also, as will be shown later, good prospects in the Highlands for making ethnographic studies which will assist in interpreting archaeological discoveries.

The contrasts which this raises with the coastal areas are interesting. It is known that a human died near Aitape some 5,000 years ago⁵ and that within the last 3,000 years or so people were widely settled in island Melanesia, where they produced pottery and shell

¹ White, 1965b, p.335.

² See Ch. 10.

³ Lampert (1966), pp.7-9.

⁴ Mr B. Craig, pers. comm.

⁵ P.S. Hossfeld, 'Radiocarbon Dating and Palaeoecology of the Aitape Fossil Human Remains', Proceedings of the Royal Society of Victoria, 78, 1965, pp.161-5.

artefacts.¹ We may suspect that man occupied coastal New Guinea around the same time as he occupied Australia - 20,000 or more years ago.² Yet so far no traces of this presumptive early occupation have been discovered. Many ideas might be put forward to account for this but the only currently satisfactory one is that insufficient survey has been made: no search has taken place, for example, along the north coast of the island as far east as the Huon Peninsula, where rock shelters are reported to occur.³ Evidence of early settlement probably exists, but I still think that to find it will be no easy task.

¹ M.E. Shutler and R. Shutler Jr, 'A Preliminary Report of Archaeological Explorations in the Southern New Hebrides 1963-1964', n.d., mimeo; J.R. Specht, 'Excavations on Watom Island, 1966', n.d., A.N.U., mimeo.

² C. White, 'Early Stone Axes in Arnhem Land', Antiquity, 41, 1967, pp.149-52.

³ J.M.A. Chappell, Dept. of Geography, S.G.S., Australian National University, pers. comm.

CHAPTER 3

FIELD METHODS AND ANALYTICAL PROCEDURES1. Introduction

All excavations and the analyses of material from them have been carried out according to the same basic principles, which are described in this chapter. This chapter also records the definitions and the procedures used to derive results. Modifications required by particular problems are described in the appropriate site chapter.

2. Excavations

The procedures discussed here were used in the excavation of shelter sites in the Eastern Highlands. The open site of Kosipe was dug differently.

The excavation techniques were designed to produce the following data:

1. Stratified dated sequences of artefactual material;
2. The position of implements in sufficient detail to allow for the discovery of horizontal and vertical distribution patterns;¹

¹ J.M. Matthews, 'The Hoabinhian in South East Asia and Elsewhere', unpublished Ph.D. thesis, A.N.U. (1964), Ch.7.

3. All possible floral, faunal and other ecological data;
4. Sufficient information about the material in the deposit and the way this was built up to see whether this could provide useful data for the prehistorian.

A base line was laid out and a datum point fixed, usually by hammering a nail into the cave wall. The site was then gridded into excavation units of square metres, which were lettered in one direction and numbered in the other. The deposit was normally removed with triangular-headed Harris Standard paint scrapers, brushes and ash-shovels. Except at Aibura, all excavation was done by the author or Mrs C. White.¹ The excavation units were five or ten centimetre spits, depending on conditions at that point in the site. At all times the trend of the visible stratigraphy was followed as closely as possible, with spit depths being adjusted to conform to this where it seemed necessary. The depth below datum at the base of each spit was measured at nine points with a tape and line level.

The position of all artefacts recognised in situ was recorded three dimensionally by relating the artefact to two designated sides of its square metre and by recording its depth below datum. All artefacts so recorded were numbered sequentially within each square and both square and number were written on the artefact. These artefacts

¹ Department of Anthropology, A.N.U.

were washed and permanently numbered the same evening. A record was made of the spit from which each artefact came.

The rest of the deposit was screened through 1/4" mesh circular plastic sieves¹ by local labourers, usually 12-16 year old youths. From the retained fraction they removed all bone, shell, worked stone and other foreign material. I inspected all sieves before any remaining material was dumped. The retained material was bagged by spits. Later it was washed and I roughly sorted it in the field so that only pieces of archaeological interest were brought back to Canberra.

I took samples for radiocarbon dating wherever a hearth or congregation of carbon lumps was found. Owing to the small amount of macroscopic carbon in most sites and a misunderstanding on my part as to the total amount of carbon required for dating purposes,² I took fewer good samples than I would now like to have. The position, nature and environment of each sample was recorded.

Samples of all characteristic soils were taken from each site. In three sites I obtained a vertical column sample, consisting of a bag of soil taken from each alternate ten centimetres. The position of all samples was recorded.

¹ These light, sturdy sieves are extremely useful in the tropics and for surveys.

² H. Polach and J. Golson, 'Collection of Specimens for Radiocarbon Dating and Interpretation of Results', Australian Institute of Aboriginal Studies, Manual, No. 2, 1966, pp.24-6.

3. Fauna

A wide range of faunal remains is found at all the Highlands sites. Mammals, both wild and domesticated or feral, predominate, while birds, reptiles, mollusca and fish also occur.

Ideally, faunal collections from archaeological sites should be analysed to provide maximum information about the 'cultural filter' through which they have passed.¹ For example, the range of animal types represented, when contrasted with the total faunal picture of the area today, will give some idea of hunting specialisation, environmental and cultural changes in past times and also the environments exploited by prehistoric men. The relative numbers of different bones of a particular species will provide information about prehistoric butchering techniques. The amount of meat represented by the bones has sometimes been used as a basis for inferring human population size.²

To discuss such problems it is insufficient simply to identify the range of animals present at a site. One must know the number, age and size of animals present. Every bone must be identified to species level. The ecology of each species must be known.

¹ C.A. Reed, 'Osteo-Archaeology', in D.R. Brothwell and E.S. Higgs (eds), Science in Archaeology, 1963, pp.210-1.

² See also R.F. Heizer, 'Physical Analysis of Habitation Residues', in R.F. Heizer and S.F. Cook (eds), 'The Application of Quantitative Methods in Archaeology', Viking Fund Publications in Anthropology, 28, 1960, pp.93-157.

Almost none of this work can be done for Highlands animals since their taxonomy is still badly defined. The current taxonomy is based almost entirely on skull (especially dentition) and skin forms.¹ It has been common zoological practice not to preserve the post-cranial skeletons, so that in Australia there are no collections of these available for comparative study by the archaeologist. While many excavated post-cranial bones could probably be identified by a specialist, the few experts are unable to find time for such a laborious task. Consequently, none of the excavated post-cranial bones have been identified.

All mandibles and maxillae have been identified to order level, usually to generic level and to species in some cases. All mammal identifications (except some rodents) have been made by the author or Mr J.H. Calaby.² Collections of skulls in the Australian Museum,³ in the Division of Wild Life, C.S.I.R.O., and my possession have been used as the basis for classification. Messrs B.J. Marlowe and J.H. Calaby have advised on nomenclature.

¹ See, e.g., G.H.H. Tate, 'Studies on the Anatomy and Phylogeny of the Macropodidae (Marsupialia)', Results of the Archbold Expeditions No. 59, Bulletin of the American Museum of Natural History, 91 (2), 1948, pp.233-352; E.M.O. Laurie and J.R. Hill, List of Land Mammals of New Guinea, Celebes and Adjacent Islands, British Museum (Natural History), 1954, pp.115-6.

² Division of Wild Life, C.S.I.R.O., Canberra. Mr Calaby's constant help in all faunal matters is gratefully acknowledged.

³ Made available by courtesy of Mr B.J. Marlowe, Curator of Mammals, to whom thanks are given.

The large collection of rodent mandibles and maxillae from Aibura site has been identified by Mr J.A. Mahoney.¹ He points out that the current taxonomy of Highlands rodents is extremely confused and needs thorough revision on the basis of the large collections in the British Museum and the American Museum of Natural History.² Mahoney has also provided some information about the habitats of various rodent species. I have used his identifications as a basis for work on other site collections.

All mandibles and maxillae have been separately listed, sorted into left and right side³ and, with some animals, adult and juvenile. Within-spit fragments have been summed to make whole sides. From these counts, minimum numbers of animals can be calculated either for the site as a whole or for any part of it. In all cases the largest number in one of the four units - left or right, mandibles or maxillae - is the minimum number of animals.

The use of only mandibles and maxillae in discussing faunal collections is not normally recommended. While they may be useful in discussing some specialised

1

Dept. of Geology, University of Sydney. Mr Mahoney's willingness to undertake this task is gratefully acknowledged. His identified specimens can now be used for reference.

2

Mahoney, pers. comm.

3

As is the case with most archaeological faunas, nearly all mandibles are broken at the symphysis so that they are technically half-mandibles. I follow common usage, however, in calling them mandibles.

questions,¹ some features of the fauna may be overlooked. For example, if some heads are removed at the kill spot, there will appear to be fewer animals at the site than there really are. In the present collections, mandibles and maxillae represent 5-25 per cent of the total number of identifiable bones.² The standard for archaeological collections seems to be 15 per cent or less.³ Even this is considerably higher than any theoretical expectation (1-2 per cent), and must be attributed to over-representation of the more robust bones of animals due to disappearance of some fragments by, for example, burning or non-collection by the archaeologist. The reasons for the very large numbers of mandibles in some Highlands sites will be discussed later.

It is difficult to obtain sufficient information about the ecology, habitats and sizes of Highlands animals,

¹ E.g., E.S. Higgs and J.P. White, 'Autumn Killing', Antiquity, XXXVII, 1963, pp.282-9.

² Calculated on samples from Aibura and Batari.

³ In J.E. King, 'Report on Animal Bones' in J.J. Wymer, 'Excavations at the Maglemosian sites at Thatcham, Berkshire', Proceedings of the Prehistoric Society, n.s., XXVIII, 1962, pp.355-60, cranial material is 15 per cent of the identifiable bone. The number of excavation reports from which this kind of data may be obtained is all too rare; even in King's report it must be calculated by the reader. Compare C.S. Coon, 'Cave Explorations in Iran, 1949', Museum Monographs of the University Museum of Pennsylvania, Philadelphia, 1951. From the tables on pp.34 and 38-9 one may calculate what percentage of 'articulating pieces' or 'shaft fragments' is formed by teeth and jaws. Neither of these figures are however, strictly comparable with my own, although the first would probably be closer.

to make reasonable deductions about the meaning of faunal changes. I have been very fortunate in obtaining some data of this kind from Dr H.M. Van Deusen,¹ who is an acknowledged expert in the field. He points out² that until animals are clearly identified to species level some environmental inferences are of doubtful validity. He stresses that although in thousands of cases the exact habitat of individual animals is known, it is at present rather dangerous to generalise about any species of mammal in New Guinea as there are so many variables. However he is optimistic that the occurrence of different mammal species at different altitudes in the Highlands will eventually be put to good use in assessing the altitudinal zones in which prehistoric hunting occurred. A difficulty in applying this idea comes from the fact that many Highlanders today hunt over a wide altitudinal range. Therefore any prehistoric alteration in the altitudinal zonation of a species, however caused, may not be detected since the hunters would simply catch the animal downhill (say) from the site rather than uphill.

In spite of uncertainties about specific identifications and habitats, and using only mandibles and maxillae, I have made some inferences about the fauna. The relative proportions of animals hunted is deduced by assuming that prehistoric practices are similar to modern ones and all animals are brought back to the site for

¹ Curator of the Archbold Collections, American Museum of Natural History, New York.

² Van Deusen, pers. comm.

butchering. Change in the proportions of animals present at different times has allowed me to make some environmental inferences, though only of a gross kind since the habitat information is so limited. Some suggestions are made concerning the age and importance of domestic animals in the Highlands. All these inferences are limited, but they are more than is normally done with Australian-type fauna from archaeological sites.¹ The limitations will remain until some systematic well-identified collections of post-cranial bones are available for comparative study and more detailed studies of the ecology of a number of Highlands mammals have been published.²

All mollusca have been identified by Dr D.F. McMichael.³ He has also provided some information about

¹ F.D. McCarthy, 'The Archaeology of the Capertee Valley, New South Wales', Records of the Australian Museum, 26, 1964, pp.241-2; D.J. Mulvaney, G.H. Lawton, C.R. Twidale, 'Archaeological Excavation of Rock Shelter No. 6, Fromm's Landing, South Australia', Proceedings of the Royal Society of Victoria, 77, 1964, Appendix 1 (by N.A. Wakefield), pp.494-8, provides the beginnings of a discussion, although the data cannot be re-analysed as can King's (p.48, note 3, above); R.M. Jones, 'A Speculative Archaeological Sequence for North-West Tasmania', Records of the Queen Victoria Museum, Launceston, 25, 1966, pp.3-7, shows some promise of providing the first good data of this kind in Australia.

²

The recent paper by H.M. Van Deussen and K. Keith, 'Range and Habitat of the Bandicoot, *Echymipera clara*, in New Guinea', Journal of Mammalogy, 47, 1966, pp.721-3 is a good example of what is needed for all Highlands mammals.

³

Curator of Molluscs, Australian Museum, Sydney. Dr McMichael's help over two years is gratefully acknowledged.

habitats and advice about the uses to which certain genera are put by man.

Some birds, and all human remains, reptiles and fish have been identified by specialists, whose reports are given in the respective site chapters.

4. Joins

Whenever any stone material was handled, an attempt was made to see whether broken implements could be joined together, flakes replaced onto their cores and so on. In many cases, of course, tools or flakes which are broken in antiquity remain close together in their square and spit, but in some cases they migrate both horizontally and vertically. This may occur both before and after deposition. Some causes of migration of pieces of artefact within a deposit have been discussed recently by Matthews¹ and he illustrates a possible instance of this. But he does not document the vertical extent and percentage occurrence of migration. I suggest that this may be measured by joining together pieces of stone. It is clear that the amount of migration will vary greatly according to the site, the character of its soil, intensity of occupation and so on. Given thousands of waste flakes - and only these provide a large enough sample - the physical problems are daunting. It is also apparent that any attempt to work on this problem is

¹ J.M. Matthews, 'Stratigraphic Disturbance: the Human Element', Antiquity, XXIX, 1965, pp.295-8. I have benefited from discussing these problems with Dr Matthews.

likely to produce an answer distorted by investigators remembering better what they have most recently seen. Yet this method seems to hold most promise for a numerical assessment of this problem.

In these sites I have been able to join very few pieces and, since analysis was done by vertically rather than horizontally adjacent units, it may appear that there was rather more vertical movement than actually occurred. In spite of these limitations one or two pointers of interest have emerged which will be discussed in relation to particular sites.

5. Stone Tool Analysis

1) Introduction

S. Bulmer, in a series of papers,¹ has defined the most important tool types which occur in the Highlands industries. These include axes, waisted blades and pebble tools. Some comments on her typology and my use of it follows.

These fairly well defined groups form only about ten per cent of the stone tools found in excavations. The other 90 per cent are a heterogeneous group of small flaked tools which present major analytical difficulties neither considered or discussed by Bulmer. Some of these problems are discussed below.

The section starts by outlining the analysis of stone material other than implements.

¹ S. Bulmer, n.d., 1964a, (1966).

2) Waste Stone

Waste stone comprises all pieces of stone upon which no traces of secondary retouch or use were observed. Nearly all are flakes but a number of shattered, ill-defined lumps are included. It is probable that some of these stones were used as tools but macroscopic traces of such use were not found; short of examining all pieces under a microscope there is no way of detecting which were used as tools. However, most of this stone probably represents the unused by-product of knapping.

At two sites the number of pieces of waste stone was weighed and counted. However at Kafiavana the number was so large that, although all the waste was weighed, only samples of it were counted. Where it seemed that the relative proportions of different raw materials changed over time or in relation to the number of implements in those materials, samples from different levels of the site were analysed further.

At all sites, samples were analysed to see whether the size of the waste material changes over time. The sizes were defined by drawing a series of squares on paper and fitting the stones into them. The sizes are multiples of half an inch square.¹ When fitting stones into the squares they were laid with the largest dimension - normally the bulbar surface for flakes - down. These results are compared with those of the weight analyses.

¹ The sudden intrusion of a non-metric measurement is regretted, but it could not be corrected.

3) Trimming Flakes

This name has been given to flakes, the dorsal surfaces of which carry considerable portions of retouch. This retouch normally occurs on the dorsal edge of the striking platform, but it may also run in a 'keel' down the dorsal surface or, occasionally, in other directions. It is usually truncated by the edges of the flake.

Trimming flakes can nearly always be distinguished from flakes which carry on their dorsal surfaces the record of several previous attempts to remove them from their cores. There is more retouch on a trimming flake and the retouch is longer than a few millimetres: in addition this retouch is normally step-flaking and not the rather amorphous deeply concave shattering that appears on ill-struck flakes.

The presence of these flakes results from the striking of a large flake from an 'altered edge', normally using the base of this edge as a platform. This can be seen to have occurred on a number of worked edges. The most likely interpretation of these flakes is that they result from the premeditated removal of a heavily retouched and used edge so as to resharpen it. Some, of course, may result from the accidental removal of flakes during a retouching process and this is particularly likely to be true of those with a very small striking platform. A similar process has been recorded, for example, by Clark in the United Kingdom Mesolithic¹ and

¹ J.D.G. Clark, Excavations at Star Carr, 1954, p.100.

noted in passing by Mulvaney in Australia.¹ In the Highlands industries trimming flakes form quite a large percentage of the stone pieces which show signs of a secondary retouch. This reinforces the idea that they are not occasional or accidental pieces, but relate to a particular stage in the process of creating and using an implement. This class was not recognised by S. Bulmer.

4) Cores

Most cores seem to have been used and retouched subsequent to their being cores.² These are included in the implement analyses.

Apart from these, there are only some chunks and large flakes which have been used haphazardly as cores. The flaking seems to be entirely ad hoc with no attempt at preparing platforms or even consistent use of a single platform. There seems, therefore, to be little that these cores can tell us and no particular study of them has been made. It is interesting to note that in regard to its cores, the industry fits well within the South-East Asian tradition.³

¹ D.J. Mulvaney and E.B. Joyce, 'Archaeological and Geomorphological Investigations on Mt. Moffatt Station, Queensland, Australia', Proceedings of the Prehistoric Society, n.s., XXXI, 1965, Table 3 and p.172.

² See p.53.

³ D.M. Walker and A. de G. Sieveking, 'The Palaeolithic Industry of Kota Tampan, Perak, Malaya', Proceedings of the Prehistoric Society, n.s., XXVIII, 1962, p.113.

5) Axe-adzes

Like S. and R. Bulmer,¹ I define all pieces of ground stone which resemble those hafted and used as axes or adzes in recent times as 'axe-adze' or 'axe'. In the absence of the haft there is no way of distinguishing blades hafted as axes from those hafted as adzes.² It should be noted that native informants are also unable to distinguish these types.³

The terms used in the description of these tools follow closely the definitions given by Davidson and others for Polynesian adzes,⁴ with two modifications.

1. With symmetrical Highlands axes it is immaterial which face of the tool is towards the observer, since no distinction can be made between faces.

2. The cross-sections recorded by Davidson have been added to by Bulmer⁵ who used the term 'planilateral' to refer to axes which are basically lenticular but which have flat sides. I have adopted this term.

1

S. and R. Bulmer, 1964, p.53.

2

S. Bulmer, 1964a, pp.247-8.

3

M. Strathern, 'Axe Types and Quarries: A Note on the Classification of Stone Axe Blades from the Hagen area, New Guinea', Journal of the Polynesian Society, 74, 1965, p.185.

4

J. Davidson (ed.), 'A Guide to the Description of Adzes', by members of a study group of the Auckland University Archaeological Society, New Zealand Archaeological Association Newsletter, 4, 1961, pp.6-10.

5

S. Bulmer, 1964a, pp.247-9.

The two most important features of Highlands axes are usually taken to be the presence of grinding (which is said to link them to the beginnings of agriculture¹) and the shape of the cross section, which is claimed to have pan-Melanesian cultural and chronological significance.² Bulmer has already pointed out that an axe blade with two sides and two faces is not necessarily 'quadrangular'.³ It should also be added that there has been no study of any collection of Highland axes to show that a particular cross-section can be consistently defined and metrically separated from its neighbours. It is not difficult to envisage a cross-section index, perhaps the ratio between thickness at the centre and at the side of an axe.⁴ This index, when applied to a large collection from one area, would give a graphic picture of the cross-sections, which could be compared with others from different areas, and subjective judgments avoided. Only then will one be able to test, for example, the claim that 'planilateral' and 'oval-lenticular' sectioned axes are characteristic of the Western and Eastern Highlands respectively.⁵ My inspection of collections in the Australian Museum and the

¹ S. and R. Bulmer, 1964, p.66.

² E.g., Riesenfeld, 1950, pp.641-5.

³ S. Bulmer, 1964a, p.249.

⁴ For the elegant construction of indices of this type see D.A. Roe, 'The British Lower and Middle Palaeolithic: Some Problems, Methods of Study and Preliminary Results', Proceedings of the Prehistoric Society, n.s., XXX, 1964, pp.245-67.

⁵ S. Bulmer, 1964a, p.255.

Department of Anthropology, A.N.U. suggests that there is an increase in 'flat-sidedness' from east to west, but exactly how this is expressed and what it means I have not yet determined.

The same general criticisms may be applied to statements about the temporal priority of lenticular axes,¹ with the additional point that the numbers studied so far are statistically insignificant.²

6) Waisted Blades

These axe-like implements have a pronounced indentation flaked on each side.³ These indentations occur either as a pair of notches ('waisted')⁴ or as a reduction in width of the butt part ('shouldered').⁵ The flaking is similar to that on axes and some are wholly or partly ground.

S. Bulmer has also included within this definition unground or slightly ground blades which are markedly widest at the cutting edge with 'a slight reduction in their sides, giving a concave appearance'.⁶ This

¹ S. Bulmer, 1964a, p.267; S. and R. Bulmer, 1964, p.66; S. Bulmer (1966), p.157.

² S. Bulmer (1966), p.108a and p.129a.

³ S. Bulmer, 1964a, p.267.

⁴ S. Bulmer, 1964a, Plate 2, lower three implements.

⁵ Ibid., top left implement; S. and R. Bulmer, 1964, p.63, figure 3 (d).

⁶ S. Bulmer, 1964a, p.252.

definition may be too broad because it includes some axes. However, the presence of these specimens underlines the difficulties of separating axes and waisted blades into two absolute categories. One useful method may be the construction of length and breadth indices. This can be done as follows:

The implement is oriented on a measuring board with one line on the graph paper passing through both points of maximum indentation of the side notches. Four length, three breadth and three thickness measurements are taken as illustrated in Figure 3.1.¹ The maximum thickness is recorded at the three points where breadth is measured. The implements are also weighed. Indices drawn from these measurements will allow all implements to be compared. It can be shown, for example, whether implements are notched at a particular place (l_1/l_2), whether they are basically rectangular (Br_1/Br_2) and so on. If necessary these indices could be compared with those derived from axe blades. Eventually it should be possible to see whether implements may be classified on the basis of their metrical features.

Although I have taken these measurements, there are too few waisted implements in the excavations to make the use of indices worthwhile.

7) Tools with use-polish

These tools are simply large flakes or chunks of stone which show a high gloss along one or both surfaces

¹ Note that for shouldered specimens l_2 and Br_2 will be inapplicable.

of one or more margins. This gloss is much more shiny than polish induced by normal grinding and it is more closely restricted in area. Under a 10x magnification, the striations are much more uniform.

Too few of these tools occur for any significant statements to be made about their size and shape. Several are large flakes with pebble cortex on the dorsal surface and side. The ventral surface occasionally shows slight polish in the centre, just in the region where a thumb would rest if these tools were hand held (see, e.g., Figure 7.24 a).

Careful inspection of the amount and character of the wear on these tools shows that there were several different methods of using them. The very high gloss combined with many shallow striations is good evidence that the material being worked was plastic rather than hard.¹ In other parts of the world, skin or hide-working would be logical suggestions, but in the Highlands some form of plant fibre working or even meat-cutting may be more appropriate. The precise function of these tools clearly requires further study.

8) Pebble Tools (Large flaked implements)

S. Bulmer² defines pebble tools as

implements made by steep flaking to produce a working edge on a waterworn pebble or a thick flake from a waterworn stone. The dimensions of the finished tool are nearly those of the

¹ S.A. Semenov, Prehistoric Technology, 1964, p.115.

² S. Bulmer (1966), p.87.

original pebble with waterworn cortex generally visible on more than one side. The primary flaking, other than the working edge, which is present on a minority of these implements seems to serve to flatten the pebble, rather than to alter its size or outline.

Elsewhere¹ she implies that these are distinctly larger than the normal run of flaked implements, and also points out that the unifacial working is restricted to one end or side or two sides converging to a wide point² although ten per cent are 'aberrant'.³

There are many problems of applying this definition, but they arise primarily because many Highlands tools are made on pebbles and the metrical limits of 'pebble-tools' are not defined. What is a pebble-tool?

The term 'pebble tool' is widely applied to crude industries in Africa,⁴ Europe,⁵ and Asia.⁶ The normal use of the term is perhaps best expressed by Mason who refers to: 'rough quadrangular pebbles [with] a sharp edge prepared by short shallow flakes struck from the end or

¹ S. Bulmer, 1964a, p.262.

² S. and R. Bulmer, 1964, p.59.

³ S. Bulmer, 1964a, p.263.

⁴ S. Cole, The Prehistory of East Africa, 1964, p.126.

⁵ M. Kretzoi and L. Vertes, 'Upper Biharian (Intermindel) Pebble-industry Occupation Site in West Hungary', Current Anthropology, 6, 1965, pp.74-87; L. Vertes, 'Typology of the Buda Industry a Pebble-Tool Industry from the Hungarian Lower Paleolithic', Quaternaria, VII, 1965, pp.185-95.

⁶ H.L. Movius Jr, 'Palaeolithic Archaeology in Southern and Eastern Asia, exclusive of India', Cahiers d'Histoire Mondiale, 2, 1954, pp.257-82 and 520-53.

side either unifacially or bifacially'.¹ He also points to signs of repeated sharpening in the form of short step flakes.²

This definition has been broadened by others to include split pebbles and 'tabloid chunks',³ as well as flakes.⁴

The distinction between end and side flaking has been used as a major feature of South East Asian pebble tools,⁵ although only Movius admits that he has chosen this solely to facilitate description.⁶

A second basic distinction is drawn in S.E. Asia between bifacial and unifacial flaking.⁷ The Highlands tools are all unifacial and therefore resemble Movius' 'choppers' and 'hand-adzes' and Sieveking's 'cleavers'.⁸

While these definitions suggest Highlands pebble tools fall within the general limits of this class, none of them separate these tools from those normally called 'scrapers'. Movius states:

¹ R. Mason, Prehistory of the Transvaal, 1962, p.129.

² Ibid., p.130.

³ Walker and Sieveking, 1962, p.117.

⁴ Movius, 1954, p.261.

⁵ Ibid., p.261; Walker and Sieveking, 1962, p.119.

⁶ Movius, 1954, p.261.

⁷ Ibid.; K.G. Heider, 'A Pebble Tool Complex in Thailand', Asian Perspectives, II (2), 1958, p.65.

⁸ Walker and Sieveking, 1962, pp.117-9.

The only difference between a chopper and a scraper is one of gross size...Normally, a chopper is manufactured on a core, whereas scrapers are usually made on flakes....Both are flaked on the upper surface along one side only so as to produce a unifacial tool with a round, semi-oval or straight cutting edge.¹

He also points out that his classes are not rigid and 'the probability of any two individuals agreeing on the classification of any one of the assemblages...is extremely remote'.²

Neither Movius nor Sieveking,³ who also uses size as a criterion, have set up any metrical limits to their classes; nor do they even indicate a range of acceptable sizes for them. Bulmer has done this in part by saying that the maximum length of her pebble tools ranges from 1.9 to 6.0 inches, and the maximum weights from 44 to 1086 gms.⁴ She does not actually show that size and weight will serve to distinguish pebble tools as a group or to isolate sub-groups within this group.⁵

¹ Movius, 1954, p.261.

² Ibid.

³ Ann Sieveking, 'The Palaeolithic Industry of Kota Tampan, Perak, Northwestern Malaya', Asian Perspectives, II (2), 1958, pp.95-7.

⁴ S. Bulmer, 1964a, p.262.

⁵ This failure, together with the poor definition of other attributes and the lack of any statistical tests of the reliability of results derived from a small sample vitiates her attempt to demonstrate three functional groups of pebble tools. See S. Bulmer, 1964a, pp.263-4 and (1966), p.112.

Inspection of the samples excavated from Kafiavana and Niobe, however, convinces me that there is a group of tools which is distinct from the normal run of flaked tools. They are larger than the normal flaked tool and are usually about fist size. They are commonly made in light-coloured non-greasy chert or darker coarser-grained rocks, whereas smaller tools are largely made of fine-grained dark cherts. Pebble cortex frequently provides the unretouched side of a retouched edge; this is not common in smaller tools. Some of the pebble tools may be cores, to judge from the flaking on them. This feature is paralleled in a pebble-tool made at Legaiyu village in 1964¹ (Figure 3.2). Step-flaking is fairly common on the rest of these tools, suggesting that many were retouched. Retouched edges vary in number and extent; some pebble tools have only a short length on a side or end,² whereas others look like an Australian 'horsehoof'.³ At times retouch may occur on more than one plane.⁴ Pebble tools are not therefore distinguishable by the extent or type of retouch.

It is these somewhat subjective criteria which have been used to isolate pebble tools at Kafiavana and Niobe

¹ This tool was made as a demonstration of flaking by Kanakevi during a short visit in 1964. It is illustrated in the film 'The Bowmakers'.

² Measured in relation to the long axis.

³ F.D. McCarthy, Australian Aboriginal Stone Implements, The Australian Museum, Sydney, 1967, p.18.

⁴ Cf. H.M. Cooper, 'Large Stone Implements from South Australia', Records of the South Australian Museum, VII, 1943, p.350.

and to state that there are no pebble tools at Batari and Aibura. It seems to be true that until these tools can be defined on the basis of their function, and until larger samples are available, little more can in fact be done.

The pebble tools from Kafiavana and Niobe cannot, even when several attributes are taken into account, yet be shown to form a distinct group. For example, the smallest of 21 pebble tools at Kafiavana weighs 114 gm. and there are nine non-pebble tools heavier than this. Pebble tools are not exclusive in their use of raw material or in the amount of retouch and so on. They have been kept as a class primarily because as the site chapters show, their occurrence appears to be temporally and geographically variable and may therefore have cultural correlates. However, in the 'edge analysis' (see below) they are included with other flaked tools.

The foregoing arguments suggest that, in the Highlands, the term 'pebble tool' needs to be more fully defined and its place within the local industries investigated before it can be finally admitted as a separate type.

9) Large Flake Tools

According to the most recent definition,¹ this type includes both utilised flakes and worked flakes with a markedly thick side opposite the utilised side. They range in length from 3.9 to 6.0 inches, and at Yuku are 'clearly separated' from other flake tools which are less

¹ S. Bulmer (1966), p.88.

than 2.8 inches in length. There are only 15 of these tools, including seven utilised and eight retouched flakes.¹ At Kiowa these tools form a continuous size series with smaller flake tools.² In all sites reported here also this type cannot be separated on the basis of size. Thus, large flake tools cannot be shown to form a valid type in the Eastern Highlands, although it may prove to be so further west.

10) Other Types

S. Bulmer also records eight bifaces³ and, at Kiowa, five burins.⁴ Neither of these types appear in my material.

11) Flaked Implements⁵

More than 90 per cent of all retouched implements in the Eastern Highlands industries would normally be called 'miscellaneous scrapers'.⁶ All collections of these implements show a very high degree of similarity since

¹ S. Bulmer (1966), p.129a, wrongly gives the totals as five and ten and, according to the level reports (pp.118-28) has reversed the positions of these two sub-groups.

² S. Bulmer (1966), p.88.

³ S. Bulmer (1966), pp.108a and 129a.

⁴ Ibid., p.108a.

⁵ A diagram showing the method of drawing all tools of this kind is given in Figure 3.3.

⁶ Compare Mulvaney and Joyce, 1965, p.182.

they are largely composed of small chunky formless tools with a high incidence of step-flaking.

Some tools are utilised but not retouched: these are usually treated in a cursory fashion¹ but are so characteristic of the Eastern Highlands industries that I have analysed them in detail here.

The flaked implements are characterised by the following features:

1. Retouch is nearly always unifacial and usually step-flaking.
2. On many tools there is a wide variation in the amount of retouch visible on closely adjacent parts of the same edge.
3. The retouched edges are often concave in shape.
4. The face which is retouched is often a large negative or positive bulbar surface.
5. Most implements have a flattish 'base' on the unretouched side of an edge.
6. The angle between face and base is generally a steep but acute angle.
7. Retouch is not only associated with one flattish base but is often found in more than one plane of the tool.
8. The edges of many tools bear chipping which is much finer and closer to the actual corner between face

¹ Mulvaney and Joyce, 1965, p.175; J.D.G. Clark, 1954, p.114.

and base than normal retouch. This seems to be macroscopic use-wear or modification and a reasonably consistent division between it and retouch can be made.

9. Most implements are made on chunky pieces of stone.

The problem then is to analyse these seemingly very similar industries in a meaningful way.

The construction of a typology poses a number of problems. I must point out initially that it may be misleading to talk of the typology of any assemblage. It is being shown increasingly in other disciplines that not only do groupings depend upon an arbitrarily chosen acceptable level of similarity between the units,¹ but also that classifications should be regarded as being profitable in relation to a particular problem rather than true or false or even probable or improbable.² This is normally said of numerical taxonomies which are, in

¹ P.H.A. Sneath, 'The Construction of Taxonomic Groups', in Microbial Classification (Twelfth Symposium of the Society for General Microbiology, April 1962), 1962, pp.307-10. (I owe this reference to Mrs A.C. Minson).

² This is best stated by W.T. Williams, 'The Computer Botanist', Australian Journal of Science, 29, 1967, p.268: '...the most important single feature of computer classifications [is that] they are not unique. We can provide virtually infinite answers from the same set of data. Even the intensity of groupings is under our control; for by making only a small change in the numerical model we use, any data can be made to appear completely devoid of internal clusters, or as intensely clustered as the user may desire. It follows that a computer classification is in no sense absolute; it carries no authority and it does not, as some of its
(cont. p.69)

archaeological terms, more concerned with ordering types,¹ but it is equally true in regard to defining them.² Thus several typologies may be constructed whose usefulness be ranked differently according to the problem under discussion.³

A frequent purpose of archaeological typologies is to describe material so that it can be compared with other

2 (continued from p.68)

practitioners seem to have believed, represent some kind of revealed truth. Its function is to suggest to the user what groups, or what boundaries between groups, might repay further study; its test lies in what Dr Lance and I have called profitability and what Dr Goodall has called utility'.

See also G.N. Lance and W.T. Williams, 'A Generalised Sorting Strategy for Computer Classifications', Nature, 212, 1966, p.218; and compare M. Harris, The Nature of Cultural Things, 1964, pp.14-5: 'A particular mode of classification is good or bad depending upon the kinds of results which can be achieved with it. If the classifications reveal orderly relations, it is a good classification; if it reveals nothing but chaos, it is worthless'.

1

E.g. Matthews (1964), pp.141-4; F.R. Hodson, P.H.A. Sneath and J.E. Doran, 'Some experiments in the numerical analysis of archaeological data', Biometrika, 53, 1966, pp.311-24; L.R. Binford and S.R. Binford, 'A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies', American Anthropologist, 68 (2), Part 2, 1966, pp.238-95.

2

For a contrary view see V.G. Childe, Piecing Together the Past, 1956, pp.9-10.

3

An early recognition of this by an archaeologist is found in J.O. Brew, 'Archaeology of Alkali Ridge, Southeastern Utah', Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, XXI, 1946, pp.44-66.

material and eventually be used to achieve 'culture-historical integration'.¹ This simple aim is complicated by considerable argument as to whether types can or should reflect the classificatory systems of their makers,² and, for the classification of stone tools, whether formal, functional or technological criteria³ are the most important. It could well be argued that no one typology can take adequate account of all these and that prehistorians should consciously realise which they favour, constructing their typologies accordingly.

The actual method by which a typology is arrived at has rarely been discussed although problems of describing and ordering given types are frequently aired.⁴ Normally, it seems that types are defined through the intuitive recognition of clusters of attributes which are derived from both the classifier's experience and the material facing him. Only after 'satisfactory' groupings have

¹ G.R. Willey and P. Phillips, Method and Theory in American Archaeology, 1962, p.11.

² Ibid., p.13.

³ E.g., A. Leroi-Gourhan, G. Bailloud, J. Chevaillon and A. Laming-Emperaire, La Préhistoire, 1965, pp.241-71; H. Breuil and R. Lantier, The Men of the Old Stone Age, 1965, Ch. 7; Semenov, 1964, pp.94-100.

⁴ The following discussion owes much to a stimulating article by J. Sackett, 'Quantitative Analysis of Upper Paleolithic Tools', American Anthropologist, 68 (2), Part 2, 1966, pp.356-94; and to his paper 'Archaeological Interpretations in the Upper Palaeolithic', Man the Hunter Conference, University of Chicago, 1966, unpublished [quoted by permission].

emerged are the attributes defined. In many instances this method of describing rather than defining types is sufficient, since formal differences are reasonably clear. The other, less usual method, is to set up a series of attribute classes and then try to derive types by an analysis of attribute co-variation.¹ This method depends upon quantitative studies and some statistical expertise and it is now only a developing field without well-defined and readily available paths for the would-be typologist.² Thus, although this approach may be profitable in a situation - like the present one - where the intuitive discovery of types is unsatisfactory, it is unprofitable (in another sense) when time is limited.

A third possibility is to postpone for the present, a major attempt to define types and make an initial study of the variation of a series of attributes, drawing attention to some associations of clearly linked variables. The charting of unsynchronised variations of individual attributes is of course commonplace in the analysis of pottery³ and has also been used successfully in other

¹ Sackett, 1966, p.356.

² See e.g., the debate between D.L. Clark and J.M. Matthews: D.L. Clark, 'Matrix Analysis and Archaeology', Nature, 199, 1963, pp.790-1 and associated prior references. Also I.C. Glover, 'The Use of Factor Analysis for the Discovery of Artefact Types', B.A. (Hons) thesis, Dept. of Anthropology, University of Sydney, unpublished.

³ See e.g. J.H. Rowe, 'Archaeological Dating and Cultural Process', Southwestern Journal of Anthropology, 15, 1959, pp.317-24; I.H. Longworth, 'The Origins and Development of the Primary Series in the Collared Urn Tradition in England and Wales', Proceedings of the Prehistoric Society, n.s., XXVII, 1961, pp.263-306.

fields, such as in studying Polynesian fishhooks.¹ In both fields the delineation of chronological and cultural change has been made more precise by endeavouring to select those attributes which vary independently and whose presence does not normally depend on having the whole object present. An attribute analysis of all Highlands flaked stone implements conducted along the same lines should also reveal some temporal and geographical regularities, although these may be somewhat obscured by the range of form and function of the stone tools.

Two methods of studying the flaked stone are presented here. Both may be used with some profit in the study of Highlands prehistory although it is not claimed that either is the best that may be constructed. The first is an intuitive typology, of the same kind, although not the same, as S. Bulmer's.² The second is an attribute analysis, the basic design of which depends on several inferences drawn from ethnographic and archaeological data from the Eastern Highlands.

The intuitive or standard typology is very similar to the systems normally employed by archaeologists.³ Using a

¹ K.P. Emory, W.J. Bonk, Y.H. Sinoto, 'Fishhooks', Bernice P. Bishop Museum Special Publication, 47, 1959; and review by R.C. Green, Journal of the Polynesian Society, 70, 1961, p.142.

² S. Bulmer (1966), pp.88-9. It should be pointed out that my typological studies were largely completed before her thesis became available.

³ E.g. McCarthy, 1967; F. Bordes, 'Typologie du Paleolithique Ancien et Moyen', Publications de l'Institut de Préhistoire de l'Université de Bordeaux, Memoire, 1, 1961.

small number of attributes and accepting a low degree of similarity between implements, the intact flake tools were divided into a number of classes. Comparisons between archaeological units are made on the basis of the relative numbers within the classes and some assessment of the degree of similarity between members.

Apart from utilised but unretouched tools and cores, the most 'satisfactory' intuitive typology was derived by the division of tools according to the position of retouch in relation to the long axes. A series of end, side, side and end, double side, double side and end and 'discoid' tools was thus made, while some aberrant forms such as 'double concave' were separately described. Standing apart from these types are the 'multiplane' tools (7 above). These tools have retouch on several different planes so that, unlike other tools, there is no one surface which can be called a base and thus the position of the retouch in relation to the long axis cannot be judged. It will be seen later that these appear to be a significant type.

This typology has few points of contact with S. Bulmer's.¹ For a start, it must be noted that she does not record multiplane tools except as 'irregular cores', of which the only examples are two from Yuku. Considering that these form about 30 per cent of scrapers at all my sites, this absence is rather surprising.

¹ S. Bulmer (1966), pp.88-9.

She also makes a basic division into core and flake tools,¹ but this did not seem to me to be significant. For instance, she classifies a large number of unretouched tools as single platform highback cores, although they 'show signs of use'.² All my single-platform highback cores are in fact heavily step-flaked for use as implements so that their core function has been entirely superseded: it is better to classify them with similar tools made on flakes.

Her eight categories of flaked tools are based on combinations of formal and technological criteria. Thus, shape in plan and shape in section are used four times, shape of working edge three times and type of retouch five times. The limits of these definitions are only casually expressed, so that it is not easy to repeat her classification. My standard typology outlined above is at least basically repeatable by other workers.

Typologies of this sort however, only appear to be most valid when very few attributes have been taken into account in their formation. Attempts at description of these types using features other than those initially selected showed no difference between the types.³ However, this typology has several advantages. By excluding all

¹ For more than 90 per cent of the tools from Kiowa S. Bulmer states whether they were made on cores or flakes. She does not state this for concave scrapers, nosed tools and burins.

² See also S. Bulmer (1966), p.132.

³ Cf. S. R. Mitchell, Stone-Age Craftsman, 1949, pp.35-7.

implements which seem to be broken¹ some features, such as changes in the relative proportions of various types, emerge more clearly. By selecting as a primary attribute the position of edges (which was exceptionally difficult to include in an attribute analysis), this typology supplements the more detailed study. The use of this system will also allow students who do not have access to the material to understand it more clearly.

The second method, an attribute analysis, is based on ideas drawn from some studies of technology in the Eastern Highlands.²

In 1965, the making of bows and arrows with newly flaked stone tools was observed at Legaiyu and Himarata villages³ (see Chapter 4). This study was a limited one and I do not wish to place too much reliance on the details. The main suggestions which it makes however, are both explicit and supported in other ways, so that their use in this analysis seems justified.

The most important and relevant fact produced by this study is that these Highlanders do not regard a flaked tool as a functional whole. Rather, they use a piece of stone for a particular task if it has features suitable to the work in hand. Thus, a knife must have a suitable thin

¹ I.e., which have freshly broken faces, truncated lengths of retouch or other obvious signs of breakage.

² The substance of this section was presented as a paper to ANZAAS, Section F, Melbourne, 1967. See White, Mankind, (forthcoming).

³ Base camps for the excavations at Kafivana and Batari respectively.

edge, a core must be a piece of good quality chert with a suitable striking platform and so on. Apart from the need to be appropriate to the work there are only broad limitations to the shape, size or other features of tools. An implement is not regarded as a 'type' but simply as a piece of stone which may be used to perform a certain function.

Associated with this approach to tools is the way any piece of stone may be used in several different places or for several functions. For instance, it may serve successively as a core, hammer, scraper and knife provided it has a suitable platform, edge, etc. This is not a rare happening: it is quite normal.¹

The third important feature is that none of the working edges of these tools were ever retouched and the only retouch to be seen in this ethnographic industry came from attempts to remove flakes.

Now, if it were true in prehistoric times that secondary retouch did not define implements then the basis upon which most conceivable typologies of Highlands material could be constructed would be undermined, since what constituted an implement could not be determined except by microscopic study of wear traces.²

¹ Cf. G. Horne and G. Aiston, Savage Life in Central Australia, 1924, pp.91-2, for similar but more restricted behaviour by Aborigines; Semenov, 1964, pp.94-100, shows something similar for Palaeolithic burins.

² Semenov, 1964.

The site of Aibura provides the main reason for rejecting this claim. This site, which was occupied for some 4,000 years, produced about 1,100 pieces of stone of which 30 per cent were retouched, mostly with step flaking. Further, the virtual absence of flakes smaller than $\frac{1}{2}$ " square is convincing evidence that this site was not a workshop,¹ although a little knapping may have been carried on there. The retouch on these pieces cannot therefore be the by-product of using these pieces as cores unless it is argued that people carried around large numbers of relatively small cores and deposited, but did not flake, them in the cave. This seems unlikely.

This is reinforced by the actual appearance of the excavated retouched pieces. Many are retouched in several places around a platform and the retouch is spread along an edge rather than being concentrated at one point. Most of these pieces are so small that if they were cores then the flakes they produced would have been almost useless² in an Eastern Highlands context. It is also important that step-flaking is used to create working edges on some New Guinea tools. Examples of this are two obsidian sago pounders probably from the Mt Bosavi area outside the Highlands proper³ (Plates 3-1, 3-2) and two step-flaked

¹ Compare, for example, the size of waste material at Kafiavana or Batari. In the ethnographic industry 55 per cent of the waste is less than $\frac{1}{2}$ " square even though secondary retouch did not occur.

² Cf. S. and R. Bulmer, 1964, p.55.

³ S. and R. Bulmer, 1964, p.54. Mr J.N. Jennings very kindly allowed me to photograph his specimen, collected by him at Lake Kutubu. My example was bought at Goroka in 1964.

tools, precisely similar to excavated ones, collected in Barabuna village¹ in 1964. My informant said that the latter tools were used by his father for working wood and bone.

Finally, in upper levels of some Highlands sites there is a definite decline in the number of retouched pieces. The rise in unretouched but utilised flakes and chunks occurs at Aibura within the last few centuries and leads to the suggestion that the limited ethnographic study is not always directly comparable with the entire prehistoric record.

It has already been mentioned that any inspection of the excavated tools shows that closely adjacent parts of them carry very different amounts of retouch and that this is frequently found on one or more planes of the tool. It is also noticeable that retouch does not seem to be employed to change a piece of stone to conform to a particular morphological pattern. In short, it seems that these retouched stone tools might be interpreted in the same way as the ethnographic implements from Legaiyu.

Furthermore, if retouch on an edge was regarded as preparing it for use then different areas of retouch would result from preparing several edges for use. These edges might be used for the same purpose but it would be immaterial that they were in fact all on the same piece of stone. If this were so, it would be more accurate to regard a stone implement as the record of a series of discrete processes which acted on it, than as an attempt

¹

Base camp for the excavation at Aibura.

to create a specific formal type. The final shape and size of the stone is simply that considered an adequate 'handle' by the final user of it.

It is for these reasons, both archaeological and ethnographic, that it seems as if a study of retouched and used edges may be directly relevant to the understanding of the prehistoric implements.

This is not an entirely new suggestion. Mellars¹ makes the point when discussing Mousterian tools although only within the context of a classical typology. It appears to be implicit, but is not developed, in Mulvaney's discussion of Kenniff artefacts² while Jones recently suggested that Mellars' idea could be usefully applied to Tasmanian tools, although he had not yet done so.³ I believe that mine is the first systematic application of this idea to flaked stone artefacts.

The one general problem which remains to be discussed lies in the question 'what is a whole implement?' When implements are made to a set and regular pattern, deviations from that - once the range is known - can easily be detected and taken account of in the description of the type. In the case of these implements however,

1

P.A. Mellars, 'The Middle Palaeolithic Surface Artefacts' in S.I. Dakaris, E.S. Higgs, and R.W. Hey, 'The Climate, Environment and Industries of Stone Age Greece: Part I', Proceedings of the Prehistoric Society, n.s., XXX, 1964, p.231.

2

Mulvaney and Joyce, 1965, pp.171-86.

3

Jones, 1966, p.6.

many are broken or flaked in an area which is not contiguous to a particular edge. Since they are not made to a particular form there is no way of deciding whether they were broken before or after that edge was used. In fact it is only in rare cases that it can be said definitely that a piece of stone is now the same size that it was when a particular edge was used: more frequently a good guess may be made. By contrast it is usually clear whether or not a particular edge is whole. Thus, this study is complicated by the fact that in any observations on the stones one frequently cannot know which stones are whole. As a result it is often difficult if not impossible to correlate features of edges with any features of the stone implements treated as a whole.

It now seems useful to set out a schematic outline of the process which created a series of retouched edges on an implement. Note that the word implement will be used from now on to describe the stone as a whole.

An implement seems to start off with an unretouched edge, prepared for use by the removal of one or two large flakes struck from the base. The implement would then be used and this edge would become blunt. It would be resharpened by a few blows struck from the base, producing step-flaking retouch. Step-flaking therefore generally indicates which part of the tool was used. This process might continue several times until the edge became overhung or 'worked out' and unsuitable for further retouching. A rather more hefty blow would then be struck on the base several millimetres away from the edge, removing a larger flake bearing a considerable quantity of retouch on the dorsal edge of its platform, and restoring

at least part of the edge to its pristine state. The 'trimming flakes' (see 3) above) so removed may not take with them the retouch all the way along the edge and there are many implements on which this can be seen.

It is not suggested that this is the only process involved. 'Trimming flakes' might be removed by a bad strike during retouching; in some cases an edge may be retouched before it is ever used and so on. But it does seem that the above account is the most economical explanation of the material being discussed.

This analysis therefore takes as its basic unit the 'altered edges' of implements and considers the implement only in relation to each edge. The term 'altered edge' is preferred since it is neutral with respect to purpose and also allows both retouched and unretouched but used edges to be included in the definition. Other features of an implement are observed only in relation to a particular edge. An 'altered edge' is defined as: 'a length along the intersection of two surfaces (planes) of stone, one or both of which surfaces bear retouch or use-wear'.

The limits of an altered edge are defined by three criteria:

a) Any continuous length of similar use-wear belongs to the same edge, whatever other characteristics may be present within its length. However, a length of use-wear may only lie within an edge, whose ends may be defined by the other criteria.

b) When the edge is looked at in plan (i.e. in a plane at right angles to the less retouched of the surfaces which form it) it must form a straight or

smoothly curved line. For the purposes of this classification a change in direction of the line of the edge through more than 40° within a distance of less than 1 mm. is taken as marking the end of an edge.

c) A change in the type, amount or direction of flaking of the retouch. This will normally accompany a change in direction of the line of the edge. Frequently, this will be associated with a small ridge of stone, formed at the intersection of the flake scars, which will run up one surface of the stone from the point where the direction changes.

The three criteria are applied in the above order. Thus even a sharp change in direction does not mark the end of an edge if use-wear is continuous over this point. This almost never occurs.

This attempt to create a descriptive unit covering all modified edges is adequate for all but one or two per cent of the edges. In cases of doubt, the rule has been to make a division and increase the number of edges recognised.

It is a general assumption of this typology that most of these edges are prepared and used as tools of some kind. However, there may be some edges prepared for other purposes such as to give the user a better grip on the implement. This may be the case with the few unusual types of retouch, but there is no way of determining this if modification is not visible.

The code used to record the attributes of all retouched and used edges and the implements on which they occur is set out below. It is given in the numeric form

which was prepared for use on IBM cards (see below). The following artefacts are not catered for by this code - axe-adzes (5) above), waisted blades (6) above), large flake tools (9) above), tools with use-polish (7) above) and all waste material (2) above).

<u>Column</u>	<u>Category</u>	<u>Data Code</u>
Section A: Reference		
1	1.1	Site 1. Aibura 2. Batari 3. Kafiavana
2-5	1.2	Card numbers, sequential within site
6-9	1.3	Catalogue number of implement
10-11	1.4	Square number
12-13	1.5	Spit number within square
14-16	1.6	Number written on stone
17	1.7	0. implement located in three dimensions 1. implement not located in three dimensions
18	1.8	Horizon
Section B: Implements		
19	2	Type of stone <u>Site 1, 2</u> 1. chert 2. non-chert

<u>Column</u>	<u>Category</u>	
		<u>Site 3</u>
		1. red greasy chert
		2. other greasy chert
		3. non-greasy chert and other stone
20	3.1	Number of planes used in this implement
21	3.2	Number of edges on this implement
		Section C/1: Edges
22	4	<u>Whole or not whole implement</u> For this edge, implement is: 1. clearly whole or nearly whole 2. probably whole or nearly whole 3. clearly not whole 4. indeterminate
23	5	<u>Implement is made on:</u> 0. not determinable 1. core, lump etc. with pebble cortex 2. core, lump etc. with other cortex 3. core, lump etc. without cortex 4. flake with pebble cortex 5. flake with other cortex 6. flake without cortex 7. 'trimming flake' with pebble cortex 8. 'trimming flake' with other cortex

<u>Column</u>	<u>Category</u>	
		9. 'trimming flake' without cortex
		<u>Size and shape of implement</u>
24-6	6.1	Length in mm
27-9	6.2	Breadth in mm
30-2	6.3	Thickness in mm
33-5	6.4	Weight in gm
36	7	<u>Nature of base</u>
		0. not determinable
		1. pebble cortex
		2. other cortex or natural surface
		3. break
		4. negative bulbar surface
		5. positive bulbar surface
		6. not applicable
37	8	<u>Preparatory flaking</u>
		0. unclear where or if flaked
		1. none
		2. flaked from base
		3. flaked from side, top
		4. not applicable
38	9	<u>Whole or not whole edge</u>
		1. clearly whole or nearly whole
		2. probably whole or nearly whole
		3. clearly not whole
		4. indeterminate
	10	<u>Size and shape of edge</u>
39-41	10.1	Length of edge in mm
42-3	10.2	Depth of edge in mm

<u>Column</u>	<u>Category</u>	
44	10.3	Edge is 0. straight 1. concave 2. convex 3. wavy
		Section C/2: Retouch
45	11	0. none 1. light step flaking 2. heavy step flaking 3. other unifacial flaking 4. bifacial flaking 5. too complex to code or unsure of type
46-8	12	<u>Retouch angle</u>
49	13	<u>Retouch type</u>
		Repeat of category 11
50-2	14	<u>Retouch angle</u>
		Section C/3: Use-wear
53	15	<u>Use-wear type</u> 0. none visible 1. chattering 2. bifacial chipping 3. 'utilisation'
54	16	<u>Whole or not whole use-wear</u> 1. clearly whole or nearly whole 2. probably whole or nearly whole 3. clearly not whole 4. indeterminate

<u>Column</u>	<u>Category</u>			
	17	<u>Size and shape of use-wear</u>		
55-7	17.1	Length of use-wear in mm		
58-9	17.2	Depth of use-wear in mm		
60	17.3	Use-wear is: 0. straight		
		1. concave		
		2. convex		
		3. wavy		
61-3	18	<u>Use-wear angle</u>		
64-5	19	21. 11+12	41. 13+14	
		22. 11+13	42. 13+15	
		23. 11+14	51. 14+15	
		24. 11+15	61. Not	
		31. 12+13	codable	
		32. 12+14		
		33. 12+15		
66	20	<u>Use-wear type</u>		
		Repeat of category 15		
67	21	<u>Whole or not whole use-wear</u>		
		Repeat of category 16		
68-73	22	<u>Size and shape of use-wear</u>		
		Repeat of category 17		
74-6	23	<u>Use-wear angle</u>		
		Repeat of category 18		
77-8	24	<u>Position of use-wear on retouch</u>		
		Repeat of category 19		
79	25	<u>First EDP card relating to this implement</u>		
		0. no		
		1. yes		

Explanation of the code

Section A: Reference

This section gives all essential record and stratigraphic data about the implement being described.

Categories 1.2 and 1.3 facilitate card counting and data checking. Both categories are required, 1.2 for discussing edges (one per card) and 1.3 for numbering implements (one or more cards per implement).

Category 1.4 records the square in which the implement was located. For EDP purposes the letter-number designation of squares was converted to a simple number.

Category 1.7 notes whether the implement was seen in situ and its coordinates taken or whether it was only recognised as an implement in the laboratory.

Category 1.8 records the horizon to which this implement is attributed. The definition of arbitrary horizons was necessary when soil or implement stratigraphy did not divide the implement into groups, but where sequential, temporal divisions of the site were required for analysis. The methods of attributing implements to horizons are described in the site reports.

Section B: Implements

This section records data relevant to the stone implement as a whole. All data in this section is repeated on all cards referring to a particular implement.

Category 2 is the only item in the code which varies between sites. The stone types were defined after handling the material from each site.

Category 3.1 refers to the number of planes with used edges on them. A plane is defined as 'a surface such that every straight line joining any two points in it lies wholly in it' (OED). Given that chert does not fracture in entirely flat surfaces this definition has been reasonably closely adhered to for the purposes of this description.

Section C/1: Edges

The data in this and the following sections record the attributes of a particular 'altered edge' as defined above. Since each edge is described separately one EDP card is used for each edge.

Category 4 - this item records whether the implement is whole or not whole in relation to the edge being described. For example it may be clear that since this 'altered edge' was created there has been little or no further modification of the implement, i.e. it is 'whole' in relation to this edge. As well, there may be on the same implement the remains of another edge, but in this case the implement has clearly been considerably modified since the edge was created, i.e. it is not whole in relation to this edge.

'Nearly whole' refers to the situation where more than 90 per cent of the implement seems to be present.

'Probably whole' is an assessment made when the implement seems to be whole but one cannot be quite sure.

Category 5 - the category 'core, lump, etc' refers to all implements which are not patently flakes. 'Trimming flake' has been defined above (Section 3)). The division

of each item in terms of cortex was used to assist in discussing the definition of 'pebble tool'.

Category 6 - these measurements are of course directly relevant only to those edges for which the implement can be clearly defined as whole. In all these cases the shape and size of the stone are those which were acceptable to the final user of the implement. In all other cases the measurements provide a description of the implements.

To measure length and breadth the unretouched or unused side of an 'altered edge' (i.e. the 'base') was placed flat on a measuring board and the implement then fitted into the smallest containing rectangle, the longer side of which was taken as length. Thickness was taken as the height at right angles to the board. All measurements were taken to the nearest millimetre.

Bifacially retouched edges were measured in the same way with the positive bulb¹ of a flake placed onto the board where possible.

Attention must be directed to the fact that for edges on different planes the implement will have different measurements since a different 'base' will be placed on the board. Observations suggested that there is a quality of 'chunkiness' about many implements whose edges are unifacially step-flaked, and this could be best expressed by taking measurements on the implement in relation to each edge. This method also takes account of the fact

¹ Using the terms of K.P. Oakley, Man the Tool-maker, 4th edition, 1958, p.11.

that the 'edge' is the basic unit and that the implement as such is only significant in relation to its edges.

All implements have been weighed to the nearest gram as well as measured. In some cases, there appears to be some overall change in the size of implements through time, and weight seems to be the best measure of this, for it is independent of any specific orientation of the implements.

It must be stressed that since these implements are not made to a set pattern, there can be no obvious way to orient them for measurement. Further, the indices of shape which I have constructed, such as length/breadth and breadth/thickness, are simply coarse expressions of a particular feature and not a basis from which total morphology may be re-constructed.

Category 7 - a base can only be defined when an altered edge is retouched or used on one side only. The other, unretouched, side is then called the base. Item 2 is used when the surface appears to be that of the original piece of chert which was not a river-rolled pebble. Negative and positive bulb (items 4 and 5) are used in conformity with the definitions of Oakley.¹ Item 7 allows for the cases such as bifacial retouch and some utilised flakes where one cannot clearly determine which side of the edge should be called the 'base'.

Category 8 - preparatory flaking refers to the removal of one to two large flakes from the non-basal side

¹ Oakley, 1958, p.11.

of the edge. These flakes are nearly always larger than retouching flakes and they are not usually step-flaking, so that they are normally distinguishable from retouch. Item 4 refers to the same implements as item 7 of category 7.

Category 9 - this category records whether or not an 'altered edge' is whole. The limits of 'probably whole' and 'nearly whole' are the same as those outlined for category 4.

Category 10 - this measures the size and shape of an edge. The length is taken as the chord between the two ends of the edge (L_c). The depth (D) is taken as the maximum distance of the edge from this chord, as measured by a line drawn at right angles from any point along the chord.

Category 10.3 describes the general shape of the edge. A straight edge will, of course, have no depth (i.e. 10.2 = 0). A wavy edge, defined as a combination of any of the other three items in 10.3, also has no depth which can be recorded.

The length (L_c) and depth (D) of an edge are used to derive an indentation index.¹ This is the ratio L_c/D , which expresses the degree to which edges diverge from a straight line. This index is not a measure of the curvature of an edge, which would be best measured by fitting the edge to one of a series of circles of varying

¹ The two measurements have been taken by McCarthy, 1964, pp.197-246, but he has not constructed an index of this type.

radii. The indentation index is an attempt to associate edges which are equally divergent from a straight line no matter what their actual size. For convex edges L_c/D may be termed a projection index. The actual size of edges can be determined simply by observing their length (L_c).

Measurements of length and depth were taken together by means of small-scale, transparent measuring board. To construct this a piece of graph paper was photographically reduced to millimetre scale and projected onto a piece of transparent line film.¹ The film was held rigid by attaching it to a piece of clear plastic. The edge to be measured was held with the base against the film on the other side of it from the observer, so that a clear view of the maximum extent of the edge in both directions could thus be gained. The instrument was found especially useful where edges were 'overhung'.

Section C/2: Retouch

Section C/2 records the retouch on an edge. According to the definition of an edge it is possible, if rare, that one edge will be retouched in two different ways. C/2 makes provision for this. Categories 11 and 13 make provision for the four types of retouch that were noted. The division between light and heavy step-flaking is an arbitrary one, recording whether few or many flakes have been removed.² Other uniaxial flaking was nearly all scalar, consisting of fine thin flakes which ran out

¹

The help of Mr W. Ambrose is gratefully acknowledged.

²

Cf. Sackett, 1966, pp.363-4.

flat rather than ending in a step. Bifacial flaking was rare and may result from the conjunction of two sides which were unifacially flaked. Since one could not be sure of this the item of bifacial flaking was included.

Categories 12, 14 - the angle of the edge was measured with a goniometer. The angle measured was the general angle formed by the two surfaces of stone which meet to form the altered edge. Close to the junction of the two surfaces the angle could not be measured accurately, but consistent results were obtained by taking a series of measurements of the angle between the base and the general configuration of the other surface.

It must be stressed that this angle is measured only along those parts of an edge which are retouched. Where the edge is unretouched this angle is not measured.

Section C/3: Use-wear or modification

Section C/3 records the use-wear¹ on an angle. Since it is possible that any one edge may contain more than one length of use-wear, provision has been made to record two lengths on any edge. Provision could not be made for more than two lengths since IBM cards contain only 80 columns. In only one or two cases did this lead to any difficulty.

Categories 15, 20 - three types of use-wear were recognised

¹ This term is used to describe all very small chips which seem to result from the tool being used. Occasionally they may be in fact the result of flaking. Plates 4-20 to 4-23 show use-wear on ethnographic tools and Plates 5-7 to 5-9 show it on excavated artefacts.

a) 'chattering' comprises very small flakes crushed from one side of an altered edge and extending less than 1 mm up the surface of the stone.¹ Under a 10x lens 'chattering' often has the appearance of minute step flaking. In general a 'chattered' edge is undercut so that when the implement is placed with the base flat the other surface of the stone slightly overhangs it. This type of use-wear may resemble the fractures resulting from several blows struck in attempting to remove a flake: however, these tend to be concentrated within a small compass and to create a characteristic smooth, deeply concave shaped edge. Chattering often extends over a length of more than 5 mm, and is regular and continuous.

b) Apart from the fact that it is found on both surfaces of an edge, 'bifacial chipping' exhibits some of the same characters as chattering. However, the size of the flakes is more irregular, with larger ones being especially noticeable. The flaking also tends to be slightly more invasive than in 'chattering'. This is a rare type of use-wear.

c) 'Utilisation' is used to refer to all traces of use-wear which do not fall clearly into the other two categories. In general it refers to wear which is much finer and more irregular than chattering or bifacial chipping. Such wear may be the snapping of small 'bites' out of the edge of a thin blade, thin short flakes removed at irregular intervals from one side of an edge, occasional bifacial flakes and so on. It is not suggested

¹ Mitchell, 1949, p.35.

that 'utilisation' results from one way of using an edge or even from a series of closely similar usages. It is rather a record of the fact that the edge has been used in some way which results in a type of use-wear which is not chattering or regular bifacial chipping.

Categories 16, 21 - this records whether or not this length of use-wear is whole. The limits of each category are the same as those of category 9.

Categories 17, 22 - the size and shape of a length of use-wear is measured and recorded in the same way as the size and shape of an edge (category 10).

Categories 18, 23 - the angle measured is the general angle of the edge along the length of this piece of utilisation (see category 12, 14).

Categories 19, 24 - these items record the relationship of use-wear to retouch. It is clearly possible, in terms of the definition of an 'altered edge' that one piece of utilisation may be associated with more than one type of retouch. By the use of two columns sufficient alternatives are provided to allow for any possible combination of retouch.

Category 25 - this category was put in at the suggestion of the programmer to allow the selection of one card referring to each implement. All information about implements (Sections A and B) is contained on these cards and this category allows them to be referred to quickly.

Data Processing

The analytical requirements and the facilities available both suggested that electronic data processing (EDP) was the most economical way to organise and process the coded data.

It is both a merit and demerit of EDP that one must decide at the beginning exactly which data are to be used and how they are to be recorded. To add new data, redefine concepts or make a mistake is costly in terms of time, IBM cards and nervous energy. But this in turn should mean that the classifier is much more careful of the precision of his definitions and the relevance of his observations. However, it must be stressed that the selection and definition of data are done in precisely the same way as with more usual methods of data processing.

The data from each site were encoded square metre by square metre, working from top to base of the site. The data from each vertical excavation unit ('horizon') were therefore encoded in as many groups as there are excavated squares and these groups came to my attention at different times, spread out over the entire encoding time for that site. Thus, if there was any long-term fluctuation in my observation of attributes this will show across the site at all levels rather than from top to bottom over the whole excavated area. One possible extraneous distortion has thus been removed from the assessment of intra-site changes through time, which is one of the main analytical problems.

Once the data were encoded, punched onto IBM cards and validated, questions concerning the occurrence of

attributes and correlations between these were asked through an IBM 360/50 computer.¹ Results were returned to me in the form of two-way tables, each numeric table being complemented by column and row percentage tables. Not all answers are used here as they require refining and reducing to bring out salient features and avoid overwhelming the reader with a mass of data.

It should be pointed out that a computer has been used simply in order to perform fast, accurate arithmetic. It has not 'proved' any conclusions: these stand or fall on their archaeological merits.

Omissions from the Code

Three features were omitted from the code which it might have been valuable to have put in. The first two were omitted because of practical difficulties; the third seemed logically unnecessary but might in practice have been interesting.

i) The first is a record of the sequence in which edges were made on an implement. If this could be determined then, since the final edge would be known, the features of many more implements could be related to particular edges. A number of attempts were made to assess the sequences on some implements but consistent answers could not be

¹ The program used was a variation of the Survey Analysis Program used in the Research School of Social Sciences, A.N.U. It was written and applied to the data by Miss M. Rose, Programmer of the Research School of Social Sciences. A fuller account of the program is given in Appendix 3.2. Miss Rose's patient and considerable help is gratefully acknowledged.

obtained from several archaeologists, or by myself over a period of time.¹ Therefore I did not attempt to record this sequence. This means that the actual process which created each implement - and therefore the technology of the industry - is less well recorded than it might be. But one can still see the relative duration of this process by reference to the number of edges on an implement and there is also a complete account of what the implement finally looks like.

ii) The next is the position of an edge relative to other edges on the implement. It might have been useful to see, for example, whether edges on an implement were normally contiguous or not.² It was omitted primarily because it was an extremely unwieldy characteristic to incorporate; in any case the standard typology takes some account of this feature.

iii) From the earlier discussion it will be clear why the code excludes any assessment of whether an implement is whole, except in relation to a particular edge. It might nevertheless have been interesting to include this assessment - though it is made, of course, in the selection of implements for inclusion in the standard typology.

In conclusion, having used this code, my reaction is that it is no more than a first approximation: while the

¹

Mr J. Golson and Mrs C. White were most helpful in examining this problem.

²

Cf. Mulvaney and Joyce, 1965, p.182.

logic seems to be sound, there is no doubt that further work is required on many of the concepts involved in it.

CHAPTER 4

AN ETHNOGRAPHIC STUDY OF THE MAKING
OF BOWS AND ARROWS WITH STONE TOOLS

The opening up of the highlands of Australian New Guinea during and after the Second World War provided the last opportunity to observe neolithic cultivators in their uncontaminated state and it is tragic that it should have been so largely missed: many anthropological research workers, indeed, went there, but these concentrated mainly on certain aspects of social structure and kinship and neglected to make a complete and balanced study of these last communities of neolithic type.¹

More people who have experienced a pre-metal economy live in the New Guinea Highlands today than in any other part of the world. Their technology, based on stone and wood until the 1930's,² was influenced by the introduction of metal tools as gifts or trade items.³ It is now changing more rapidly than other aspects of their traditional life.⁴ Because of this and because

¹ J.D.G. Clark, 'Traffic in Stone Axe and Adze Blades', Economic History Review, ser. 2, XVIII, 1965, p.19.

² E.g., Salisbury, 1962.

³ E.g., I.F. Champion, Across New Guinea from the Fly to Sepik, 1932, pp.125 and 127; J.K. McCarthy, Patrol into Yesterday, 1963, p.96; M.J. Leahy, Diary, 8 June, 1930 and passim.

⁴ Salisbury, 1962, pp.1-3 and 205-7.

ethnographic studies may help us to understand archaeological data,¹ I decided to spend some time in studying the making of bows and arrows with flaked stone tools.

This study was mostly made in Legaiyu village - the base camp during the excavation of Kafiavana shelter (see Map 2) - in March-May, 1965. My main informants and workmen were Tounamo and Kanakevi, whose ages I estimate at around 50 or more years. They were assisted by several other senior men. All the data therefore came from men who were probably at least 15-20 years old in 1930 and who grew up in a stone-using society. A further short study was made with men of a similar age at the Batari campsite. The processes in both areas are so similar that the Batari data, which comes from the making of one bow, has been integrated with the rest. All workmen were paid a per diem rate.

The various methods and techniques of bow and arrow making were recorded in both movie² and still photography. The general account given here is derived from notes taken during the making of each bow and arrow. I would have preferred to describe the making of one bow in detail, and then to make comparisons with others, but my studies were not detailed enough to permit this.

¹ E.g. B. Allchin, The Stone-tipped Arrow, 1966, pp.19-21; Ascher, 1962, pp.360-9; J.D. Clark, 'Human Ecology During Pleistocene and Later Times in Africa South of the Sahara', Current Anthropology, 1, 1960, p.309; J.D.G. Clark, 1965, pp.1-28.

² I have made an 8mm film of the process of bow and arrow making. Called 'The Bowmakers', it is in colour, with a sound-track and runs for 25 minutes.

I asked people to make and use stone artefacts for a specific task to help disguise the fact that I was primarily interested in the stone tools themselves. I wanted to avoid getting answers given merely to please me, and also to study what tools were needed and how they were used rather than simply have this described. I therefore had stone tools used to make six bows, then broad-bladed bamboo arrows and three barbed arrows. I decided on bows and arrows because my informants consistently said that stone artefacts were only used for wood-working, and bows and arrows seemed to be the main wooden artefacts present in Legaiyu.¹ Bamboo or bone knives were used to cut up food, while facial hair was pulled out; few spears and shields were made and woodcarving was not practised. But every man today has at least one bow and a dozen or more arrows. There are no shotguns in the village, so that bows and arrows remain the only weapons used today.

A number of problems have not been studied. It was noticeable that some men were regarded as skilled in particular operations and would often be called upon to perform them:² for example, a Bena Bena man living in the village was usually asked to make the fibre bindings around arrows. But time was too limited for me to study the work of these men and contrast it with others. Similarly, statistically valid studies of the tool:waste ratio, the variation induced by raw material, the local classifications of stone artefacts and many other aspects

¹ Compare Blackwood, 1950, Ch. 3.

² Compare Salisbury, 1962, p.57.

were not studied. I have concentrated on the type and range of flaked tools used and a few simple time and motion studies.

The following account first describes the wood-working techniques and afterwards analyses the stone tools used. Three main types of tools were used to make bows and arrows: flaked stone tools, a ground stone axe and bamboo knives. I have deliberately left the description of these tools until the end of this chapter so that their form may be interpreted only after their function is understood. All tool terms other than axe and bamboo knife (e.g. plane, scraper) refer to unhafted flaked stone tools.

1. Bows¹ (habou)²

At Legaiyu, the wood used for bows was a knot-free black palm (nouma) (probably Carvota sp.) brought from beyond Okapa. I was told that in pre-European times it was bought from Henganofi people. The wood arrived in the village as a triangular sectioned piece (base 4.5-5 cm., vertical height 3-4 cm.) some 1.9-2.2 metres long (8 measured). The base of the triangle is bark with many leaf scars on it while soft white fibrous pith forms the apex. Between these two is the hard streaky black wood from which the bow is made. The wood came to the village

¹

I wish to acknowledge the help of Dr R. Hoogland and Mr R. Pullen of the Division of Land Research C.S.I.R.O. and that Division's Herbarium respectively, in the identification of plant material.

²

The orthography in this chapter is my own.

fairly green and was allowed to dry for about a month hung in the hot smoky rafters of a hut.

All Highlands bows are symmetrical self-bows and thus their manufacture involves a simple reduction of the original billet to the final bow shape. Initially a hafted stone axe was used for 20-30 minutes to remove most of the pith and trim each end of the billet down to a point. The axe-man sat or squatted, holding the wood so that one end rested on the ground and the other leaned out to the left front at an angle of about 30° from the vertical. Using the hafted axe the stroke involved considerable movement of both elbow and wrist, but limited shoulder motion. The axe blade was nearly vertical at the moment of impact (Plates 4-6, 4-7). I noticed that when the hafted axe was temporarily unavailable because of resharpening or re-hafting, the workers used an unhafted ground axe or even an axe-sized split pebble for chopping. Neither of these was used if the hafted axe was available.

The major work in bow-making was done by planing (scraping), which on three bows took 7, $8\frac{1}{2}$ and 10 hours respectively. Planing was done sitting down. A right-handed person positioned the bow across the body projecting to the left front, so that part rested on the right thigh with the end sticking out behind the operator. The left hand held the wood and the end beyond this rested on the ground. Planing was done on the section of wood between the right thigh and the left hand (Plate 4-8). The thick-edged plane was grasped with thumb and fingers opposing, the forefinger generally going over the top of the artefact and down to the right side of the wood. The cutting edge was held at a slight angle to the wood. The

stroke was a push from the shoulder to the full extent of the arm, with the wrist being kept stiff. At the end of the stroke the plane lay nearly flat on the wood (Plates 4-9, 4-10).

At Batari the number of plane strokes per minute was timed for a total of 107 minutes (units of 28, 38 and 41 min.). The number ranged from 12 to 105, with the three examples below 40 per minute being caused by interruptions such as splinters. Ignoring these, the mean was 75 strokes per minute. It was clear that each plane stroke removed only a small amount of wood. To clean rough areas either a thick-edged plane or thinner-bladed tool was sometimes used with the edge held vertically to the wood and pulled towards the body (Plate 4-11).

After planing the bow was 1.75-1.84 m. long (6 measured) with a thickness:width ratio of 1.5-2.5:1 at the centre of the stave. In cross-section it was somewhat D-shaped with the bark surface being markedly flatter than the other; no grip was made.

In order to form each nock, two circular grooves were cut around the bow about 1 cm. apart and 5-6 cm. from the end. Each groove was about 2 mm. deep and took about three minutes to cut with a sharp, thin flake (Plate 4-12). The body of the bow was then planed down to the inner groove while the nock-end (from the outer groove to the end) was cut and scraped to a tapering point with a vertically held scraper (Plate 4-13). Bamboo knives were used to remove small splinters and trim up. The finished nock thus consisted of a ring of wood upstanding around the body of the bow near each end. It was made in 20-30 minutes.

Bowstrings (mnena) were made from the flexible skin of a bamboo (not further identified) which has nodes ca. 50 cm. apart instead of the more common 30 cm. This material was traded into the village from towards Okapa, and arrived as a string 2.3-2.5 m. long and 1.5-2.2 cm. wide (4 measured). First the inner white wood was removed by cutting it with a bamboo knife at a node and peeling it down to the next node. The nodes themselves were thinned down with bamboo knives. One end of the string was trimmed down to a width of ca. 0.5 cm. and a cut was made into the pith about 1 cm. from the end. From this cut, which did not penetrate through the skin, 3 or 4 peelings were pulled back about 20 cm. The same process was repeated at the other end and the string was dampened and left to cool and shrink. The peelings were then tied in a knot which was fitted to one nock. With the string lying along the stave the correct positioning of the second knot - about 8 cm. short of the actual bow length - could be judged. Bows were always strung with the bark side toward the bowman since the natural tension of the wood is in the other direction.

The workers then made some tests of the pull and balance of the bow and parts of the stave and string which were not correct were thinned down. The completed bow was left strung for a day or two to set the curve but after this it was stored unstrung.

To prevent splintering, the front of the bow was sometimes treated with a mixture of squashed berries (not identified) and fine brown soot scraped from house rafters. With time and use this acquires a fine dark brown patina.

Bows are said to last at least two years, but I think may well last longer; bowstrings appear to last only six months or so.

The six bows made at Legaiyu during this study range from 174 to 183 cm. long (mean 178 cm). The height of male people in this area is normally around 145-155 cm.¹ These bows are thus rather longer, both absolutely and in relation to human height, than the bows of the 'Kukukuku' studied by Blackwood.² All Highlands bows, however, are longbows³ rather than short jungle bows.⁴

Since a small number of bows were made, no reliable idea of the number of tools used per bow can be given, but I estimate that about 12 stone tools might be used - an axe, six planes and five scraper/knives. About a day and a half - between 9 and 15 hours working time - is required to make a bow once the raw material is to hand.

In order to gain some idea of the efficiency of steel as against stone tools, I asked Tounamo and Kanakevi to make two bows with steel tools. Using steel tools for part of the work it took 7 and 4½ hours (the shorter time for a very thin piece of wood) to ready a bow for

¹ J. Kariks, O. Koopzoff, M. Steed, H. Cotter, and R.J. Walsh, 'A Study of Some Physical Characteristics of the Goroka Natives, New Guinea', Oceania, XXX, 1960, p.231.

² Blackwood, 1950, pp.40-1.

³ J.D.G. Clark, 'Neolithic Bows from Somerset, England, and the Prehistory of Archery in North-west Europe', Proceedings of the Prehistoric Society, n.s., XXIX, 1963, p.68.

⁴ G.B. Silberbauer, Report to the Government of Bechuanaland on the Bushman Survey, 1965, p.54.

stringing from a raw billet of wood. A steel axe was used instead of the stone one to remove bark and pith, and rather more material was removed. The nocks were cut with bush-knives in 7-8 mins each, a much shorter time than was required with stone. Bowstrings were prepared with small kitchen knives. However, stone was still used for planing the bow-stave. This not only points to the fact that there is no satisfactory steel equivalent of a one-handed plane available in Legaiyu, but also reinforces the idea that stone tools used in the study were not simply ad hoc inventions made to please me.

2. Arrows

Highland arrows are always composite, consisting of a pointed wooden head and a hollow reed shaft into which the head is bound. All arrows are unfletched.

Three types of arrowhead were made at Legaiyu:

- A. broad-bladed bamboo heads;
- B. barbed heads (of various kinds);
- C. three or four-pronged heads.

These classes clearly are - or were - functional, with A being used for pigs and men, B generally for hunting and fighting and C for birds and small game.¹ It is my impression that the functional distinctions between A and B have now largely broken down with the cessation of inter-tribal warfare.

¹ Compare S. Kooijman, 'Material Aspects of the Star Mountains Culture', Nova Guinea (Anthropology), 2-3, 1962, p.27.

Class A and B arrows were made for me with stone tools.

i) Class A: The bamboo was collected from a clump about a mile from Legaiyu. A length about 60 cm. long and with a node about 15 cm. from one end was split lengthwise into sections 2.3-3.4 cm. wide. It was then chopped and scraped into a lanceolate shape with the widest part (2-3 cm.) at some 25-40 cm. from the tip. The node usually lay a few centimetres behind the actual tip and was placed there to strengthen it. At the broadest point the arrow was trapezoidal in cross-section with the broader face formed by the outer skin of the bamboo. Behind the widest part the head narrowed rapidly to a slightly tapered, rounded shank 1-1.3 cm. wide and ca. 10 cm. long. A small notch was cut on either side at the top of the shank to facilitate binding.

The head was shaped mainly by scraping with stone flakes, which were also used to chop with at times. The flakes tended to be thin, with acute angled edges. They were often held between thumb and middle finger with the blade vertical to the wood and the forefinger providing pressure. In this case the cutting stroke was towards the body. They were also used with the blade held at 30-40° to the plane of the arrow or even with the blade held nearly flat onto the wood. In this case the cutting stroke may be towards or away from the body. At the node, where the wood is harder, a stone or bamboo knife was used to whittle it away.

After shaping, the head was heated over a casuarina wood fire and bent gently over a stone to straighten it.

It took an experienced worker between one hour and one hour forty minutes to make this type of head.

ii) Class B: Straight lengths of a soft fine-grain wood (Graptophyllum sp.), about 70 cm. long and 4 cm. in diameter were cut from a tree on Koyagu hill, about 200 metres from the village. A stone axe or, if the axe was not available, a stone plane was used to remove the bark and cut the wood into shape. One third of the length was left round in section (diam. 2 cm.) and the other two-thirds was cut to a tapering point with an equilateral triangular cross-section. This work (excluding the collecting of wood) took from 35 to 70 minutes. Both sections of the head were then trimmed smooth with stone and bamboo knives, and each face of the triangular section was slightly hollowed out.

Cutting barbs was a complex process. At the base of the triangular section a notch 1 cm. wide was cut around the arrow with a stone flake. A naturally pointed flake was used to cut a tapered groove on either side of each angle. Each pair of grooves, adjacent to one corner of the triangle, extended 4-10 cms. from the notch towards the tip. Gradual rubbing with stone flakes deepened the grooves until they met under the corner. Once this happened and the outline of the barbs could be seen, work started from the notch, cutting down between the barbs and the body of the arrow. A very small thin flake or bamboo knife was used with a sawing or very light whittling motion (Plates 4-14, 4-15).

Cutting barbs was a long, delicate operation. The minimum time in which I saw a ring of three barbs made was

one hour and these were short barbs (3-4 cm.). Barbs 7-9 cm. long may take up to three hours to cut. The three arrows made for me had 15, 12 and 9 barbs. They were cut in 7, 9 and 9 hours respectively.

Both types of arrows were shafted in much the same way. Straight lengths of pitpit (Miscanthus floridulus)¹ were collected from swampy areas near the river. The outer skin was scraped clean with a stone flake and the nodes trimmed down. The shaft was straightened by heating and bending if necessary and one end was smeared with resin and bound lightly with fibre. The soft pith was bored out in a minute or less by using a sliver of bamboo held vertically while the shaft was held on it and rotated between the palms of the hands (Plate 4-18). The arrowhead shank was forced into this hole and a complex, very tight, orchid and fern binding of single fibres ('nona') was made over the join (Plate 4-16). For bamboo arrows this binding was some 3 cm. long and conical in shape, but for barbed arrows it was round and 1.5-2 cm. long. The former bindings take 1½-2½ hours to make (5 timed). A sharpened pig fibula (Plate 4-17) was used as an awl during the manufacture of this binding, although a sharpened umbrella rib is greatly preferred today.

When completed, barbed heads were normally painted to give them a more fearsome aspect (Plate 4-19). Paint was made from iron oxide (haematite) shaved with a stone flake onto a banana leaf palette and mixed with the juice of a cordyline plant. The juice was extracted by chewing and squeezing. The brush was a small fresh twig.

¹ Identified by Dr J.S. Womersley, Division of Botany, Dept. of Forests, Lae, in litt. 4/6/65.

It is worth noting that although many barbed arrowheads (Class B) found in the village now are made in black palm or a similar hardwood all my informants claimed that this was a recent development. They said that prior to the acquisition of steel tools this wood could not easily be cut and it took far too long to make barbs in it.

It will be clear from the foregoing that any one man's collection of arrows represents a considerable investment of time. To make a bamboo arrow takes probably 4-6 hours, while barbed arrows may take double or triple this time. Since men have at least a dozen and often many more arrows, and these are likely to chip or break after several shots, it seems clear that in pre-European times a considerable amount of time would have been occupied in arrow making. It is probably true, of course, that large numbers of arrows were rarely used within a short time, but they must have been in quite regular and frequent use for both warfare and hunting. I therefore think that Salisbury has underestimated the time spent on craft activities in a stone age society.¹ Blackwood's statement^{nt}, that 'men and boys spend most of their time, when they are^{re} in the village, in making bows and arrows'² seems to me to^{to} be probably closer to the truth.

¹ Salisbury, 1962, pp.108-9.

² Blackwood, 1950, p.42.

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3. Tools used in bow and arrow making

(i) Ground stone axe

One ground stone axe was used by all the workers throughout the entire study. This axe was one of a number of axe blades kept in Legaiyu when I was there, and was hafted by the workers to use in bow-making. The axe is made of hornfels and measures 10x4.2x1.7 cm., which is small by Highlands standards. It was used side-hafted; i.e. set with the blade at an angle of 45° to the line of the handle as is common in the Eastern Highlands.¹ The haft was made from the fork of a casuarina ('yar') tree with the angle between haft and handle being 60° . The stone axe was wedged into place in the haft and was bound into position with fibre. In theory each blow during use should drive the axehead more firmly into its socket but in practice the head frequently fell out and had to be rebound into the haft. Although side-hafted, this implement was clearly used and thought of as an axe and not an adze. Stone axes are never used in the village now that metal axes are readily available.

(ii) Bamboo knives

These were made from bamboo collected from a clump about $1\frac{1}{4}$ miles south of the village. A length about 30 cm. long with a node about 2 cm. from one end was split into 8 or 9 pieces each 1.5-2.3 cm. wide. The pieces were hardened over a small, smoky yar-wood fire, short periods

¹ L. Adam, 'The Discovery of Vierkantbeil or quadrangular adze head in the Eastern Central Highlands of New Guinea', Mankind, 4, 1953, p.414 (quoting R.M. Berndt).

of heating being followed by wiping with grass. This process took up to half an hour. The end opposite the node was then split carefully with a thumbnail and a sliver of soft white inner wood was peeled back towards the node leaving a hard edge of outer skin to act as the blade. The wood was split at an angle so that only a thin edge of skin was exposed in order to make the blade stronger. Bamboo knives were widely used for cutting vegetables and meat.

(iii) Flaked stone implements¹

Stone from which flaked stone tools were made was collected from the gravel banks of the Fayantina River within one mile of the village. Suitable cherts were selected by shattering the pebbles and inspecting the fresh edges and faces (Plate 4-1). Choosing enough stone to make sufficient tools for a bow generally took about two hours, and about a bucketful was collected on each trip.

Next, flakes were produced for use as tools. In Legaiyu two methods were used to do this. The core was held with the striking platform cushioned on the palm and then struck with any nearby stone that was comfortable to hold, or else it was placed on top of a rock and hit with a stone hammer until either the core broke or flakes were detached. No special hammerstones were selected for flaking (Plates 4-2, 4-3, 4-4).

¹ This section has been accepted for publication in a slightly modified form as, 'Ston naip bilong tumbuna: the living stone age in New Guinea' in D. de Sonnevill-Bordes (ed.), Mélanges R. Vaufréy (forthcoming).

It seemed to me, watching the men at work, that flakes or cores were selected for use as tools if they were of a convenient shape to hold and had a sharp edge suitable for the work in hand. Specific shapes were neither explicitly produced by preparation of the core nor selected for use from the flakes which were detached. All tools except polished axes were hand-held. If a sharp edge interfered with a comfortable grip the edge was blunted by striking it vertically several times on another stone (Plate 4-5). In this way small flakes were detached from both sides of the offending edge. This was the only form of secondary retouch to artefacts that I observed. It seems therefore that the most significant characteristic of any tool is the cutting edge and that the primary formal definition of these tools should be based on this feature.

Two main classes of flake tools were used in bow-making:

Planes. These are heavy flakes or pieces of split pebble which seemed, when I saw them in use, to have right- to obtuse-angled working edges. Planes were used to scrape the bow smooth after it has been roughly shaped with a stone axe (Plates 4-8, 4-9).

Knives. These thinner flakes were used for cutting, sawing and light scraping, especially around the nock (Plate 4-12). The angle of the working edge is acute.

Making arrows is a more delicate job than bow-making, entailing at least five different ways of using stone tools:

1. Cutting - either whittling or sawing.
2. Graving - using a sharp flake as one might a penknife tip to cut grooves or clean out tricky corners.
3. Scraping - with the sharp edge held approximately vertical to the wood, the tool is drawn towards the body.
4. Scraper-planing - with the cutting edge held at $5-30^{\circ}$ to the wood, the tool is moved towards or away from the body.
5. Light chopping.

The angles of the working edges of these arrow tools were measured and it appeared that specific cutting edges were not needed for specific jobs. Since a knife could serve for all these functions, all these artefacts are called knives.

With these field observations in mind, tests were made to see if these functional groups could be formally distinguished. The tools were weighed and measured, the most critical feature, the angle of the cutting edge, being measured with a template former and goniometer.

First, planes could be separated from knives because the cutting edge of knives, whether used in bow or arrow making, is more acutely angled than that of planes. Figure 4.1 (upper), in which each working edge on a tool is separately measured, shows this difference. Function here has a formal correlate. Here too my impression based on field observation was corrected by measurements showing that some planes have acute-angled edges, though mostly less acute than those of knives. Moreover, those knives used for bow-making cannot be separated by formal criteria from those used to make arrows.

On the basis of other formal characters (e.g. length, breadth, weight etc.) knives and planes cannot be separated into two distinct groups. Figure 4.1 (lower) shows this by comparing the weights of tools. This lack of separation occurs partly because some tools were used for both purposes and were counted in both groups. But even when these multi-purpose tools (9 of 56) are excluded from the sample two distinct groups are not formed (Figure 4.2 (upper)). It can be observed, though, that knives tend to be lighter and thinner than planes. This is to be expected since, in the same way as one does not use an axe to sharpen a pencil, a tool suitable for bow-planing is not normally used to fashion arrow barbs. Thus because functional differences were observed in the field a formal distinction between planes and knives can be made. If these tools came from an archaeological assemblage these functional classes could not be distinguished since the particular edge that had been used would not be known, so that formal divisions could not be made. This is shown in Figure 4.2 (lower) in which it is assumed that the functions of the Legaiyu tools are not known and the tools have been simply plotted by weight. From this graph one would assume that only a single group of tools was present.

Further distinctions between the tools can be made on the basis of traces of wear. It is well known that each way of using a tool produces distinctly different microscopic traces of wear.¹ At Legaiyu however,

¹ Semenov, 1964, pp.16-21.

macroscopic traces of wear were frequently observed on the working edges, and these have been studied. My field observations show that not all types of use produced macroscopic traces of wear on all tools at all times. When wear does occur it varies considerably according to several factors, viz., the raw material from which the tool is made, the resilience of the wood on which it is used, the form of the tool, the way it is used by each worker and the length of time for which it is used, etc. It should be remembered that only a small number of stone tools were produced in this study and it would be unwise to make general statements about the degree to which each of these material and personal factors affect the production of wear which is visible to the naked eye.

At least four different types of macroscopic wear can be identified through the activities of planing, sawing, scraping and chopping.

Planing. Of all the tools studied planes show the least signs of use. Often the only sign of use is that the working edge feels blunter than one freshly broken. Few or no chips large enough to be seen even under a 10X magnifier were removed after an hour's continual use. Generally speaking, the more acute-angled the cutting edge, the more chips will be removed. These chips are detached from the side of the tools closest to the wood, and here also longitudinal scratches can occur at right angles to the cutting edge.

Sawing (Plates 4-22, 4-23)¹. The edge of a thin flake used as a saw breaks fairly quickly. If the blade is

¹

The reference number on this tool is Leg/B/13/5.

moved out of the vertical plane small semi-circular pieces, like bites, are snapped out of the edge. This type of wear is found mostly on thin blades, for when the cutting edge is formed by the end of a hinge fracture it is considerably stronger and heavy pressure is needed to detach chips. When fine work such as barb cutting is being done, a knife is usually discarded after several chips have been detached. However, if it is retained a serrated edge will develop in due course.

Scraping. In a thin tool held vertically to scrape wood the edge will also break quickly. With all the pressure being applied to one side of the edge small flakes are rapidly pushed off the other side. Unlike sawing, the scraping activity does not require a sharp cutting blade, only a sharp edge, and, since a tool is worn only at one side of the edge, it will continue to be used even after a number of chips have been removed. Plate 4-20¹ shows the wear resulting from cutting and scraping, while Plate 4-21² shows the wear on a tool which was held at 70-90° to the wood and drawn towards the body.

Chopping. Here the tool receives a slight knock at the moment of impact and small chips are removed on the side away from the wood. This is very like the wear seen on axe-blades, although with axes larger chips are removed.

¹ Reference number Leg/B/7.

² Reference number Leg/B/19/10.

Scraper-planing and graving. These activities produce few macroscopic signs of wear. The former is light work which removes only an occasional chip. Graving requires the use of a fine knife point so that if a single chip is detached from the operative end the tool is thrown away.

This ethnographic study was made primarily to help interpret prehistoric artefacts, and some assessment of its relevance to this can now be made.

It must be stressed first that the tools made in Legaiyu are entirely without secondary retouch. Had they been dug out of a prehistoric site they might never have been recognised as tools or, at best, would have been classified as 'utilised flakes'. The Legaiyu evidence and other studies, especially in New Guinea and Australia,¹ suggest that they are in fact an important part of some stone-age tool-kits. Many prehistoric industries contain large numbers of these tools but they are usually only perfunctorily treated.² One reason for this seems to be

¹ Blackwood, 1950; Horne and Aiston, 1924.

² J.D.G. Clark, 1954, p.114; J.D. Clark and J. Walton, 'A Late Stone Age Site in the Erongo Mountains, South West Africa', Proceedings of the Prehistoric Society, n.s., XXVIII, 1962, p.9; J.D.G. Clark, E.S. Higgs and I.H. Longworth, 'Excavations at the Neolithic site at Hurst Fen, Mildenhall, Suffolk, 1954, 1957 and 1958', Proceedings of the Prehistoric Society, n.s., XXVI, 1960, p.215; D.J. Mulvaney, 'Archaeological Excavations on the Aire River, Otway Peninsula, Victoria', Proceedings of the Royal Society of Victoria, 75, 1962, p.12. W. Shawcross, 'Stone Flake Industries in New Zealand', Journal of the Polynesian Society, 73, 1964, pp.7-25 is an exception.

that many criteria commonly used in archaeological classifications are either, like shape, inapplicable to this material or like size, do not separate these tools into groups (e.g. Fig. 4.2 (lower)). A cursory and purely formal study of prehistoric utilised flakes is therefore insufficient.

The above study of macroscopic traces of wear on unretouched flake tools seeks to show how a more adequate interpretation may be made. This method, which is not as involved and time-consuming as microscopic analysis¹, will allow the archaeologist to see how some of these artefacts may have been used. For instance, some of these prehistoric artefacts come from assemblages left by bow-making groups such as the mesolithic and neolithic peoples of northern Europe.² It is likely that the same type of activities I observed at Legaiyu were practised by other makers of prehistoric self-bows. Clark, for example, records that utilisation on primary flakes 'takes the form of minute and often irregular edge-flaking such as may easily be produced for example by trimming a wooden surface by scraping'.³ The present study shows how a further analysis of these flakes in terms of the angle of the edge and macroscopic traces of wear on them might show the part they played in the material culture of the men of the site.

¹ Semenov, 1964, pp.22-9.

² J.D.G. Clark, 1963, pp.50-98.

³ J.D.G. Clark, 1954, p.114.

Ethnographic studies in a stone-using community are also useful in showing the context in which prehistoric artefacts may have been made. One can observe the many unsuspected factors which may enter into the process of making and using stone tools. Observations of this kind are not possible in a laboratory where, as Semenov puts it, 'it is very difficult to recreate the actual conditions of work of prehistoric man and devise...experiments with these objects, used just as he would have done'.¹

On the other hand it may be pointed out that the 'actual conditions of work of prehistoric man' are not always conducive to good experimenting, for it is difficult to suspend the action while records are made, or to control the many variables involved.² Thus during the work recorded here it proved very difficult to ascertain the numbers of tools produced, keep track of the waste stone, and so on. I therefore asked Tounamo and Kanakevi to flake several cores to produce 'good' flakes - i.e. suitable for use as tools. Some data has been recorded for five of these cores. As each core was flaked all stone was divided by the knappers into 'good' and 'useless' material. I carefully collected flakes and chips which scattered during flaking and it was very noticeable that only one or two were further than a metre away from the worker, while most were retained within his hand and were normally dropped just in front of or beside him. Several

¹ Semenov, 1964, p.2.

² See for example C.M. Keller, 'The Development of Edge Damage Patterns on Stone Tools', *Man*, n.s., 1, 1966, pp.501-11.

sorts of raw material were flaked including red greasy chert and other cherts.

The following tables set out some basic data. Table 4.1 records data on cores and flakes. Tables 4.2 and 4.3 set out the sizes and weights of flakes produced, measured according to the system described in Chapter 3.

The numbers involved are too small for any significant conclusions to be drawn. It is apparent that the workers were selecting larger flakes as 'suitable'. It is also likely that to please me more have been labelled 'good' that might actually be used as tools - I noticed during bow-making that some 'tools', although ready to hand, were never used. The overall ratio of 'good' to waste flakes (1:7.7) is therefore larger than would normally be expected of a tool:waste ratio. With a more detailed and long-term study results of greater significance and utility for archaeologists could be produced. The present study suggests only what might be done in the present Highlands situation.

TABLE 3.1.3. RAINFALL DATA

No.	Date material used	Size (mm.)						Fines (mm.)			Number of plates	Number of plates before after	Ratio of plates before after	Weight (gm.) before after
		Before		After		No. (total)	No. of plates	No. of plates						
		L	B	L	B									
1	Grey green red chart	14	13	7-5	12-5	10	8	23	235	23	302	119-5	mm ²	753
2	Grey red chart	11	9-5	4	5	5	2-3	4	54	18	81	114-5	mm	67-6
3	Red grey chart	17	12	6	5	7	4	11	104	29	273	117	mm	144
4	Red green chart	10	5	3	5	5	3	5-5	mm	9	128	118	mm	65-6
5	Grey red chart	11	7	3-5	6	5-5	3	mm	mm	16	63	114	mm	91-3

L = greater than 1/2" in size.
B = not measured.

Table 4.2 : Experimental flaking - number and size of flakes

	Core number	>1 1/2"	1 1/2"-1"	1-3/4"	3/4-1/2"	1/2-1/4"	1/4-1/8"	<1/8"	Total
'Good' flakes	1	4	9	9	7	3	-	-	32
	2	3	8	3	4	-	-	-	18
	3	4	16	11	8	-	-	-	39
	4	-	4	5	-	-	-	-	9
	5	-	-	8	5	2	1	-	16
Waste flakes	1	-	-	4	16	74	210	nc	304
	2	-	-	-	5	22	54	nc	81
	3	-	-	2	21	71	179	nc	273
	4	-	-	8	15	44	91	nc	158
	5	-	-	1	8	26	28	nc	63
Total 'good'	11	37	36	24	5	1	-	114	
Total waste	-	-	15	65	237	562	nc	879	

nc = not counted.

Table 4.3 : Experimental Flaking - size and weight of flakes

	Core number	Weight in gm.							Total
		>1 1/4"	1 1/2-1"	1-3/4"	3/4-1/2"	1/2-1/4"	1/4-1/8"	<1/8"	
'Good' flakes	1	277	263	128	30	7	-	-	705
	2	167	273	28	19	-	-	-	487
	3	337	535	148	46	-	-	-	1066
	4	-	146	70	-	-	-	-	216
	5	-	-	338	66	5	0.5	-	409.5
Waste flakes	1	-	-	325	50	71	23	24	493
	2	-	-	-	16	17	5	3	41
	3	-	-	14	79	64	20	13	190
	4	-	-	60	59	37	11	6	173
	5	-	-	12	33	19	4	3	71
'Good' Total	781	1217	712	161	12	0.5	-	2883.5	
Waste Total	-	-	411	237	208	63	49	968	

CHAPTER 5

EXCAVATIONS AT BATARI, LAMARI R. VALLEY1. Introduction¹

Batari² is the name given by the Tairora of Himarata village to a small cave on the track from Himarata to Oraura, 6°36'S, 145°56'E (Map 2). The site lies about 5 miles on a bearing of 195° from Obura Patrol Post, at an altitude of 4,200 ft M.S.L. This area has been regularly patrolled only since 1963. Geologically the area falls within the Lamari Conglomerate whose volcanics, tuffaceous sandstones and calcarenites cover most of this region. Lenses of calcarenite up to three miles long and two hundred feet thick are found within the Conglomerate.³ The topography is extremely steep, with many rapidly incising rivers. The hills are all grass-covered, mostly with Imperata cylindrica and associated grasses; a few casuarina (Casuarina papuana) and pine (prob. Araucaria sp.) trees grow close to streams and some rain-forest can be seen at the tops of the higher peaks. Gardens occur on river banks, as irregular patches on hillsides and

¹

Mr J.N. Jennings, Dept. of Geography, I.A.S., Australian National University has approved the use of the technical terms in this section.

²

Reference number B65.

³

Dow and Plane, 1965, pp.12-4 and Plate 5.

adjacent to the rain forest (Plate 5-1). The area is sparsely populated.

Batari lies in a natural bridge of calcarenite over the Sorera River, a fast-flowing tributary of the Lamari River. The bridge is formed at the most easterly point of a strike belt of calcarenite which bears NW and SSW from this spot. Where it crosses the river the calcarenite is about 60 m. wide, and on its east and west sides rises almost sheer for some 40 m. above the river. The cave is on the eastern side of the bridge, about 25 m. above the river (Plates 5-2, 5-3). Its internal horizontal dimensions are ca. 15 x 7 metres, excluding a large pit falling to the river at the northern end (Fig. 5.1). The southern third of the cave is a 6 x 5 m. chamber with 2-3 m. of headroom and without fallen blocks encumbering the present floor (Plate 5-5). The rest of the cave is more irregular in both floor and roof and in the northern part there is a steep slope towards the pit. When I visited Batari in the dry season it was quite dry inside, with only occasional drips of water falling from the roof in the central part of the cave. Many small stalactites can be seen on the roof, particularly outside the southern entrance, while the eastern walls are mostly formed of stalagmitic flowstone.

The cave has three entrances, one at the south end and two at the northern end. The main entrance is the southern one, about 3 m. wide and 3.5 m. high (Plate 5-4). It is reached from the foot-track, which at this point is about 20 m. almost vertically above the southern bank of the river. For a length of some 10 m. outside this entrance the foot-track lies within the dry season

dripline, which is detected during rainstorms by water falling from an overhang 10-15 m. above the track. Above the track the ground slopes up steeply to the entrance about 6 m. away. This slope is covered with boulders many of whose corners are highly polished, apparently by constant human traffic. Between the boulders is a fine dry powdery earth, containing archaeological remains in a clearly unstratified context.

The northern entrances are smaller, more inaccessible and lie just inside the dripline. The foot-track runs along a rocky ledge about 5 m. below them.

All entrances are sheltered by casuarina and pine trees, but even without these the sun would shine into the cave only for an hour or two in the early morning.

The formation of the cave has not been studied by a geologist. Its position and general shape suggest that the river may have run through it much earlier. This is perhaps reinforced by the presence in the lower part of the deposit of many small river-rolled pebbles, unmodified by human agency. Consolidated accumulations of similar pebbles can be seen in other crevices of the natural bridge. From the configuration of the roof and walls and the presence of fallen blocks outside the present entrances it seems likely that there has been some opening-up of the forward part of an earlier, more extensive cave. This collapse must have occurred many years ago as there are no calcarenite blocks at the foot of the cliff below Batari.

There is a collection of fossilised bones incorporated in a small area of the lower part of the stalagmitic

eastern wall. The fauna represented is similar to the present¹ and the deposit probably records a predator's den in the earlier cave.

Human occupation is indicated by many rock paintings outside the cave, while inside there is a positive ochre handprint² on the back wall of the north part. Only the southern chamber, however, contains an archaeological deposit, and its walls are heavily smoke-blackened (Plate 5-5).

Men from Himarata said the cave was nowadays used only as an occasional shelter during gardening or travelling. There are certainly some legends connected with the cave and land-bridge but time and interpreter problems defeated my attempts to record these.

Discovery and Excavation

Batari was located in 1962 by Mr L. Bragge, Cadet Patrol Officer with the then Department of Native Affairs,³ while he was on patrol. He spent one morning at the site and with local labourers excavated a trench approx. 4 x 1.5 x 1 m. along the back wall of the southern chamber. From this he recovered two axes and seven flaked tools. The axes are described in this analysis. Bragge also

1

Dr M.D. Plane, Bureau of Mineral Resources, pers. comm.

2

Appendix 9.1, Batari, no. 19.

3

Mr Bragge has been most helpful in discussing his work and has kindly donated the material he recovered from Batari to the collection I have excavated.

reported the presence of many rock paintings. A limited report of his work was relayed to me by Mr W.E. Tomasetti.¹

In April 1964, during a field survey,² I visited Batari and in one morning dug a 2' x 2' x 2'3" hole, recovering many rodent bones and 157 pieces of chert, of which 17 showed signs of use or secondary retouch. This material has been included in the present analysis.

The text excavations indicate that this site had been used for working chert and that ecological data could be recovered. Further, it was in the same valley system as Aibura site but was associated with rock paintings different in both technique and style from those at Aibura. From the limited 1964 results it also appeared as if the industries at the two sites might be different, and a larger excavation was therefore made in 1965.

Batari was excavated in 3 weeks, from 4th to 24th June. I excavated all the material and did all the recording and photography. The deposit was excavated as a series of levels conforming to the general configuration of the hearth complex (see p.134), which sloped down towards the front of the cave in C3 and C4 (Fig. 5.1). Excavation started just inside the southern entrance and moved into the cave. This both increased the light for working and allowed the stratigraphy of at least one face to be studied prior to excavation. Implements recognised in situ were recorded three-dimensionally. The soil was

¹ Dept. of District Administration, Port Moresby.

² See White, 1965b, p.335.

sieved in 1/4" plastic sieves by 3-5 illiterate youths, who removed all material recognised by them as artefactual, including all bone. I inspected all sieves before any remaining material was discarded. All finds were washed in the field and I then disposed of locally derived stones.

An area of seven sq. metres was excavated to a maximum depth of 160 cm. (Fig. 5.1). Large calcarenite boulders and encroaching walls hampered the lower part of the excavation and allowing for these, my excavation contains only ca. 5.7 cu. metres of undisturbed deposit. In addition about 2 cu. metres of Bragge's infill were removed and sieved. This was very soft, and the boundary between it and undisturbed material was easily found. This fill produced a large quantity of archaeological material whose stratigraphic position is entirely unknown. Only a few important pieces such as axes and shell artefacts have been included in this analysis. I estimate that about half the deposit in Batari has now been removed.

The excavated soil could not be kept and used to backfill my excavation because of the confined working space within and outside the cave. Where undisturbed deposit remained a stone wall was built in front of it, but otherwise the trench was left open.

Stratigraphy (Figs. 5.3, 5.4; Plate 5-6)

Only one major stratigraphic feature was observable in any profile at Batari. This was a white, black and cream complex of hearths which stretched unbroken over the entire area of the excavation just below the surface. It and the material sealed in by it are clearly undisturbed.

Above the hearth was a very fine dry grey sediment about the consistency of flour, containing some cultural material. It probably includes a good deal of material thrown up from Bragge's trench, as well as in situ post-hearth cultural material. Owing to the softness of the floor, the two have been thoroughly mixed together and the whole must therefore be considered as 'unstratified'. Some heaps of bird dung on the present surface show the cave is now only intermittently visited.

The hearth complex, 1-13 cm. thick, formed a hard, crusty layer over most of the excavation, tailing out to a thin white ash along the south wall of the cave. The top of this complex lay 4-10 cm. below present ground surface. There appear to be at least two periods of burning in this complex, but there is no evidence as to how long it took to form. One hearth can be traced over at least 4 sq. m. and must have been a very large fire. The complex is largely ash, with some burnt soil and carbonised wood. Unburnt wood or large amounts of carbon were not recovered. Little cultural material was found, there being only two implements and a few animal bones in the area of the excavation.

Below the hearth complex, the deposit was a fine calcareous silt, with some rounded granules of slightly cemented silt and a few angular calcarenite fragments. As depth increased the deposit became damper, darker and rather more gritty but it retained the same high quantity of fine particles. The silt was alkaline throughout with a field pH ranging from 6.5 to 8. Stones were rare immediately beneath the hearth but small calcarenite cobbles and river-rolled pebbles of other materials

became increasingly frequent with depth. Almost no carbon was seen at any level. Directly beneath the hearth the colour ranges from 10YR7/2 to 10YR5/3. From 30 to 50 cm. below this there is a consistent slight whitening of the deposit, almost too slight to be recorded by reference to a Munsell chart but clearly visible in section. Below this the colour darkens to 10YR4/4 and patches of calcium carbonate 'frosting' concrete the earth slightly. Many bones and stones in the lower part of the deposit are partly covered with calcareous concretion.

From 90 cm. below the hearth several different layers of earth were banked against the south wall of the cave in squares F3 and parts of E3. Mostly fairly hard packed, their colours ranged from 10YR7/3 to 10YR5/2 with one patch showing many yellow flecks. These earths were stone-free and without cultural material but some spicules of carbon were collected from them. They did not extend more than 40 cm. into the cave and were not investigated in detail. Carbon occurred in the occupational debris at this level of the site.

At the base of the excavation was a fine dark loose silt without concretions but with many plant roots. Its colour was 10YR3/3 and it contained very slight traces of human occupation.

The deposit in this site can plausibly be derived from (a) weathering of the parent calcarenite, which produces some of the grits,¹ (b) transport of fine-grained

¹ I.W. Cornwall, Soils for the Archaeologist, 1958, pp.30-1.

sediments by percolating ground water, (c) human and animal transport of soil and organic material and (d) perhaps some sediments remaining from the old river level. The banked-up soils in E3 and F3 might well relate to this last cause. The very fine silt has probably accumulated in the cave through lack of wind or water removal combined with fairly intensive human occupation. The absence of features in the deposit is probably caused largely by occupational activity, for in a powdery soil even limited activity would rapidly remove hearths, ash lenses, pits etc.

A vertical soil column comprising 8 samples taken from alternate 10 cm. blocks was taken from the north wall of E4. Samples of the sterile banked soils and the hearth complex were also taken. These samples have not yet been analysed to describe their components.

Division of the Material

The deposit has been divided into four arbitrary horizons for the purpose of analysis. The horizons are numbered from the top down. In the absence below the hearth complex of any visible stratigraphy which would provide a basis for this division, I have attempted to place approximately equal and statistically significant numbers of flaked stone tools into each horizon. The base of any horizon is about the same distance below the hearth complex over the entire excavation; this has been calculated from the recorded base levels of spits. The volume of deposit in each horizon is as follows:

Horizon I	(HI)	1.8 cu. m.
Horizon II	(HII)	1.1 cu. m.
Horizon III	(HIII)	1.0 cu. m.
Horizon IV	(HIV)	1.8 cu. m.

The rationale for this arbitrary division rests on the following:

1. there are no visible indications in the site which suggest lines of subdivision;
2. deposition below the hearth is likely to have followed the same pattern as deposition of the hearth unless affected by rocks and niches. Such disturbances nearly all occur within the lowest horizon here;
3. the archaeological material does not concentrate into horizons. This is seen in the distribution of measured artefacts (52.8 per cent of the total,¹ Fig. 5.5), and of all artefacts, the scatter of waste stone (Table's 5.10-5.12) and the distribution of faunal remains;
4. some subdivision is required for comparative analysis.

The material from Bragge's trench, from the probably mixed deposit above the hearth complex and from the loose soil outside the southern entrance is all called 'unstratified'.

¹
By horizons, the percentages are: HI, 54.7 (number 137)
HII, 45.8 (number 146)
HIII, 52.4 (number 188)
HIV, 52.1 (number 144)

Table 5.1 : Correlation of horizons and spit numbers

Horizon	Square						
	C3	C4	D3	D4	E3	E4	F3
I	2-4	2-4	2-6	2-5	2-6	2-5	2
II	5-6	5-6	7-8	6-7	7-8	6-7	3
III	7-8	7-8	9-11	8-9	9-10	8-9	4-5
IV	x	x	12-14	10-14	11-20	10-17	6-9

Note: Spit 2 in all cases except F3 is the hearth complex: this had been removed by Bragge in F3.

Dating

Three radiocarbon dates are available from Batari.

1. ANU-39: 850 ± 53 years.

This is the age of 20gm. of wood charcoal from the hearth complex at the top of Horizon I. The sample was collected from a small area on the north wall of E4 after the excavation was complete. All in situ deposit below the hearth must be regarded as being earlier than this date.

2. ANU-38a (carbonate): 3570 ± 160 years.
ANU-38b (acid insoluble fraction): $\geq 8230 \pm 190$ years.

These ages refer to a sample of ca. 500 gm. of food bone remains which come from the upper part of Horizon IV, 75 - 100/110 cm. below the surface in squares E3 and E4. The sample consisted of those bone fragments from the total faunal collection which could not be identified.

The ANU Laboratory points out that the acid insoluble fraction is normally called 'collagen'. It comprises the material remaining after the carbonate has been removed and the excess acid washed off the residue. The Laboratory considers that the real date is most reasonably thought of as being equal to or greater than the age given.

3. ANU-40: $16,850 \pm 190$ years.

This date comes from 6.3gm. of wood charcoal collected in the lower part of Horizon IV, 95-120 cm. below surface in square E3. This carbon was clearly within a matrix containing cultural material, but it was not in a hearth or other man-made feature. It was at the same level and only 20 cm. laterally from undisturbed natural sediments which also contained carbon, though in much smaller pieces. There is therefore a possibility that the dated carbon, which was the only carbon to occur in any quantity below the hearth complex, was derived from the natural sediments. ANU-40 will therefore not be accepted as being validly associated with the earliest occupation of the cave, though the possibility that this was so must be borne in mind.

It should be noted that these radiocarbon dates show that the deposit at Batari was built up quite slowly - considerably more slowly, for instance, than the deposit at Kafiavana. This is consistent with the protected nature of the cave and the absence of human features in the deposit.

2. Fauna1) Domestic animals¹

Pig (Sus scrofa Linnaeus) was the only domestic animal noted. All remains came from the top horizon and all except two pieces from the hearth complex. A total of 17 identifiable bones was present, comprising 3 teeth, 10 phalanges and one each of atlas, scapula, metapodial and tarsal/carpal. At least one adult animal and one piglet are present. It is impossible to say whether the animals were domestic or feral.

2) Wild animals

The following animals have been identified:

Macropodidae :	<u>Thylogale bruijini</u> (Schreber)	Scrub wallaby.
	: <u>Dendrolagus sp.</u>	Tree kangaroo.
	: <u>Dorcopsulus sp.</u> ²	Wallaby.
Phalangeridae:	<u>Phalanger spp.</u>	Cuscus.
	: <u>Dactylopsila sp.</u> or <u>Dactylonax sp.</u>	Striped phalanger.
	: <u>Petaurus breviceps</u> (Waterhouse)	Flying phalanger.
	: <u>Eudromicia sp.</u>	'Dormouse' phalanger.

1

I am grateful to Mr C.L. Cram, ex-Dept. of Anthropology, A.N.U., for checking these identifications.

2

There is some doubt as to whether the genus Dorcopsis spp., which is difficult to distinguish from Dorcopsulus, lives in the Highlands. Van Deusen (Appendix 3.1) and Tate, 1948, p.288 ff. claim that it does not, while Dr R. Bulmer, pers. comm. claims that it does. I have followed Van Deusen throughout.

	sub-genus <u>Pseudocheirops</u> spp.	Large ring-tailed phalanger.
	sub-genus <u>Pseudocheirus</u> spp.	Small ring-tailed phalanger.
Peramelidae	: <u>Peroryctes</u> sp. or <u>Echymipera</u> sp.	Bandicoot.
Dasyuridae	: <u>Satanellus albopunctatus</u> (Schlegel)	Native 'cat'.
Megachiroptera:	<u>Pteropus</u> sp. <u>Dobsonia</u> sp.	Flying-fox.
	: cf. <u>Nyctimene</u>	Tube-nose bat.
	: <u>Syconycteris</u> sp.	Bat.
Muridae	: <u>Hyomys goliath</u> (Milne-Edwards)	Giant rat.
	: <u>Mallomys rothschildi</u> Thomas	Large rat.
	: <u>Uromys</u> sp.	Giant naked-tailed rat.
	: other genera.	

These identifications are based on mandibles and maxillae. Mandibles outnumber maxillae at this site and there is no maxilla without a corresponding mandible, so that mandibles only are used to calculate minimum numbers of animals. These calculations are based on a division of the mandibles into left and right side and into adult and juvenile. All mandibles have been called adult unless they have a deciduous dentition or erupting teeth. Taking the site as a whole at least 173 animals are present. If each horizon is considered separately the count rises to 186, as Table 5.2 demonstrates.

It can be seen that macropods, cuscus and ring-tailed phalangers make up the bulk of the fauna. There is no marked change over time in the relative proportions of animals present, though the samples are too small to be significant.

Table 5.2 also shows that the number of animals/cu. metre of deposit steadily increases with depth, there being good reasons for thinking the count for HI may be too high (see below: Rodents). This suggests either that hunting became less important as time went on, or that the intensity of this kind of site-use/unit volume of soil laid down decreased over time. When compared with the evidence from stone working which puts the highest concentration of occupation in Horizons III and II, it can be suggested that the purposes for which the site was used may have changed over time.

The environmental inferences which can be drawn from this fauna are limited as there are no clear trends in the proportions of various animals. Most of the animals are forest dwellers (Appendix 3.1) and the grassland animals such as Thylogale are not concentrated in the recent horizons as might be expected on the assumption that the grasslands are fairly recent. The fauna suggests that most hunting took place in a forest environment; today this is several hours walk from Batari. The faunal remains may therefore suggest that during the occupation of this site the forest was rather closer to the cave, although the wide altitudinal range over which many Highlanders hunt must be remembered.¹

In general, the picture of economic life at Batari is one of unspecialised hunting and gathering exploiting a wide range of fauna. When caught, most animals were brought

¹ Mr B. Craig and Dr R. Bulmer, pers. comm.

to the cave for butchering as is shown by the number of jaws.¹

It is noticeable that domestic animals form only 1 per cent of the total number of animals present, or 5 per cent of the animals of the top horizon. By comparison with present conditions, this seems considerably to under-rate the importance of domestic animals. Two explanations seem possible: either domestic animals have become much more important in this area recently, or Batari does not give a true picture of the past exploitation of domestic animals. In the latter case this may be because the cave was used largely during hunting, travelling or in time of war when access to domestic animals was restricted and more wild animals were eaten.

Rodents

A total of 360 rodent mandibles was excavated. If they are all regarded as human food remains, then they represent almost two-thirds of the number of animals in the deposit, though far less than this in terms of the proportion of food available. There are, however, certain reasons for suggesting that while some of the rodents were eaten by men, other processes must account for the majority of rodent mandibles in the site.

Two hundred and forty one mandibles, two-thirds of all mandibles in the site, were concentrated in the top

¹ Mandibles and maxillae as expressed as a percentage of total identifiable bone (samples from E3 and E4 only): HI, 10.8 per cent; HII, 11.0 per cent; HIII, 6.0 per cent; HIV, 12.3 per cent. Numbers (total) 306, 137, 217 and 1086 respectively.

Table 3.2.1. *Dermatix* identified - animal numbers of animals per herdsman.
Based on available identification only.

	Herdsman				Total no. animals/species
	I	II	III	IV	
<i>Isotia</i>	2			1	3
<i>Isotia</i> spp.		4			4
<i>Thysanota</i>	4		5		9
<i>Thysanota</i> spp.				10	10
<i>Phaenopria</i>	7	7	3	6	23
<i>Phaenopria</i> spp.				1	1
<i>Dactylopsila/Decylopsis</i>				1	1
<i>Palanus</i>				1	1
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.	3	1		5	9
<i>Palanus</i> spp.				10	10
<i>Palanus</i> spp.	2			6	8
<i>Palanus</i> spp.	4	2	1	3	10
<i>Palanus</i> spp.	1			2	3
<i>Palanus</i> spp.	1			2	3
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.	2				2
<i>Palanus</i> spp.				1	1
<i>Palanus</i> spp.	3	2	4	1	10
<i>Palanus</i> spp.			5	28	33
<i>Palanus</i> spp.	1				1
<i>Palanus</i> spp.	47	26	31	18	106
Total animals/herdsman	26.1	23.6	31	93.5	31.6
Number of animals/No. metre					

¹ Only includes numbers of animals assessed as probably eaten by humans (see text).

half of the top horizon of three adjacent squares (D3, E3, E4). This suggests a non-human depositional agency, for while it is conceivable that men might catch and eat 121 rodents it seems very unlikely that the bones would remain entirely unburnt, unbroken and in a small heap. Furthermore, the condition of all bone within the concentration and of another 17 mandibles close to it is quite different from all other bone in the site. Whereas the latter is nearly all dark yellow-brown, or charred and often broken, many rodent bones are a fresh creamy yellow and unbroken. This is true even of fragile processes. Owl pellets would produce bones in this condition.¹

The way that the other 102 mostly blackened rodent mandibles are scattered through the deposit suggests that these, at least, represent the remains of human meals. It also seems legitimate to assume that all very large rodents were eaten by men, and none of them occur in the concentration. Only these blackened mandibles have been included in Table 5.2, where they represent 69 animals (37.2 per cent of the total). In Horizon I rodents form 43 per cent of the total number of animals; this may be chance but it is more likely due to the inclusion of some owl-derived mandibles among the human-derived remains.

3) Birds

Twenty-seven pieces of bone have been identified as bird by Dr J. Yaldwyn,² but he cannot identify most of them

¹ Mr J.A. Mahoney, Dept. of Geology, University of Sydney, has inspected these bones and agrees with this interpretation.

² Curator of Crustacea, Australian Museum, Sydney. I wish to thank Dr Yaldwyn for his assistance.

to generic level. One humerus fragment from Horizon II may be fowl, Gallus gallus, but a detailed check is needed for a positive identification. None of the fragments are large enough to come from cassowary (Casuarius sp.); most are small, down to swiftlet size. Swiftlets inhabit part of the cave system around Batari today.

Birds clearly formed only a minor part of the diet at Batari since their bones form only about 2 per cent of the total number of identifiable post-cranial bones.

Many small pieces of egg-shell occur, most of them of cassowary egg. The weight of cassowary eggshell fragments averages about 0.1 gm. and there are no large fragments.

Table 5.3 : Cassowary eggshell

Horizon	No. of pieces	Wgt (gm.)	Wgt/cu. m.
I	53	6.3	3.4
II	55	6.6	6.0
III	131	16.5	9.2
IV	23	2.4	1.3
unstratified	72	7.2	-
Total	334	39.0	6.7

It is interesting that the relative amount of this shell declines in HIV. This contrasts with the picture given by other faunal remains. It should also be noted that the weight of a whole cassowary eggshell is

75-80 gm.¹ and that no more than one egg need be represented by this shell. However if this were so, this site would be exhibiting a very high degree of movement of material within it.

Most of the other eggshell comes from the upper two horizons. It has not been identified.

None of the shells has been used in any way.

4) Reptiles

The reptiles have been identified by Dr R.E. Barwick.² Among the thirteen fragments he reports 10 Agamid lizards (a family which includes the 'dragons') and one snake. At least five animals are represented. Table 5.4 shows the distribution of fragments, which are scattered through the site. It seems most likely that these animals were eaten.

Table 5.4 : Reptiles

Horizon	Family Agamidae	Other lizards	Snake	Total
I	3	-	1	4
II	7	1	-	8
III	-	1	-	1
IV	-	-	-	-

¹

Two were weighed at the Australian Museum, Sydney, by courtesy of Mr H.J. de S. Disney, Curator of Birds.

²

Dept. of Zoology, S.G.S., Australian National University. Dr Barwick's help is gratefully acknowledged.

5) Mollusca

Mollusca from three environments - marine, freshwater and land - are found at Batari. Marine shells must have been brought to the site by man, but other mollusca could have arrived through other agencies. Both freshwater and land mollusca are eaten in the Highlands,¹ and the number and spread of both types within the site suggests that humans are responsible for their presence.

(a) Estuarine - marine shells.

Eight genera of marine shells have been identified by Dr D.F. McMichael.² All specimens come either from Horizon I or unstratified contexts.

Horizon I	: <u>Oliva spp.</u>	Olive shells ³ 2 specimens.
	: <u>Polinices sp.</u>	Sand snail. 1 specimen.
	: cf. <u>Geloina sp.</u>	Estuarine bivalves. 1 specimen.
Unstratified:	<u>Oliva spp.</u>	2 specimens.
	: <u>Nassarius sp.</u>	Dog whelk. 2 specimens.
	: <u>Geloina sp.</u>	3 specimens.
	: <u>?Telligarca sp.</u>	Ark shells. 1 specimen.
	: <u>Trochus sp.</u>	Trochus. 1 specimen.

¹ Cf. S. and R. Bulmer, 1964, p.51.

² Curator of Molluscs, Australian Museum, in litt. 9/8/66.

³ Common names from McMichael, or J. Allan, Australian Shells, 1959.

- : Neritina zigzag Neritinas.
 Lamarck 1 specimen.
- : Dentalium cf. Elephant's Tusk shell.
 elephantinum 1 specimen.

The neritina has a small round hole worked in the back of the shell, probably for threading on a string. It is probable that all specimens were brought to the site for ornamental purposes. They document the existence of a trade route with the sea coast, but none of the genera are sufficiently localised to point to any particular coast.

(b) Freshwater shells.

All freshwater shells are mussels (family Hyriidae) which are common in Highland streams. Most specimens are very fragmented, but 4 have been identified as Hyridella (Nesonaia) guppyi aipiana McMichael.

The 59 specimens come from the following contexts:

Horizon	No. of pieces
I	19
II	4
III	?1
IV	-
Unstratified	35

It is equally possible that these mollusca were initially collected for the animal or its shell. If the latter were true one might expect the shells to be worked but there is no sign of this. However only one marine shell is worked and these were certainly imported for the shell.

The relative numbers of fragments indicate that more mussels were collected more recently, but the absolute numbers show that if they were collected for food they played only a minute part in the diet.

(c) Thiaridae and Neritidae

A few species of each of these families occur in freshwater in high country although Thiarids are more common in lowland streams while Nerites are essentially brack-water forms.¹ It is therefore possible that where these shells are not identified to species level they may come from any one of a range of environments. The Thiarids include Stenomelania sp. and some unidentified genera while the Nerites include a large and a small species of Neritina sp.

Horizon	Thiarids	Nerites
I	1	2
II	2	1
III	-	-
IV	-	1
Unstratified	14	5
Total	17	9

¹ McMichael, in litt., 9/8/66.

Three of the Nerites have holes drilled in the back of the shell, probably by humans. Two of these shells come from unstratified contexts and one from Horizon II.

(d) Land snails.

Two genera of land snails have been identified. The more common is Geotrochus sp. of which McMichael says¹ 'This land snail group occurs in New Guinea but I know of no species from the eastern Highlands'. Five specimens occur in HI, three in HII and one in HIII. Fourteen occur in unstratified contexts. The only other land snail is one specimen of Papuina sp., a typical New Guinea land snail, probably from the local forest. It is found in HI.

It is possible that the Geotrochus sp. specimens have been imported into this area, although trade in land-snail shells is not common. In the New Guinea situation and particularly in the remote area where Batari lies it is also possible that a species of Geotrochus occurs naturally and its presence in the site is due either to natural causes or local gathering by humans.

(e) Conclusions.

Table 5.5 documents the fact that mollusca become much more common in the upper levels of the site.

¹ McMichael, in litt. 9/8/66.

Table 5.5 : Mollusca

Horizon	Total no. shells (incl. unidentified pieces)	No./cu. m.
I	35	19.4
II	12	10.9
III	2	2.0
IV	3	1.6
Unstratified	c.80	-

This may well imply an increasing use of shells in personal adornment and/or an increased flow of shells into the area. It is noticeable that all the marine shells that can be placed into context come from the upper horizon, which indicates that trading in these shells is a fairly recent phenomenon at Batari. If one applies the absolute dates from Aibura to Batari, the marine shells might suggest that the main occupation at Batari is more than 1,000 yrs B.P.

6) Human remains

Four well-preserved human bones were found, three in unstratified contexts and one from Horizon I. They have been identified by Mr A.G. Thorne,¹ whose comments follow:

D3/(1) Upper left pre-molar. Only the crown remains of this tooth which is broken off at the root junction. The tooth is worn down to the dentine, exposing a small area of this on the buccal cusp.

¹ Research student, Dept. of Anatomy, University of Sydney.

The tooth clearly belongs to an adult person and is quite large.

- F3-4/T (Bragge's trench). Thoracic vertebra. The body of this bone is eroded and the spinous process broken. There is arthritic lipping of the bone indicating that the individual was probably adult and not young.
- C3/(1) Terminal phalange of a hand. This bone comes from one of the three middle fingers.
- C4/(3) (Horizon I). A fragment comprising less than one quarter of a pre-molar. Quite worn.

Occasional human bones are found in many caves in the New Guinea Highlands. They often seem to be associated with the deposition of corpses in niches in the rock rather than with secondary burial in the soil.

3. Artefacts

1) Axe-adze

Two whole axe-adzes, one broken axe-adze and one ground stone chip were excavated.

The whole specimens were from unstratified contexts, one outside the south entrance to the cave, the other in Bragge's trench. The broken specimen was excavated by Bragge who reports its depth at 'about 2 feet down in the deposit'. If accurate, this would place it in my Horizon III. The ground chip comes from the main hearth complex.

- i) S. Entrance, surface (Fig. 5.8). A long thick axe-adze made of gneiss containing feldspar and pyrite

crystals.¹ In cross section the axe is sub-rectangular with rounded corners. Both faces are ground smooth from butt to cutting edge and both sides appear to be bruised or hammer-dressed, which is unusual in New Guinea axes. The poll is pointed with the butt near to it being conical. At distances of 5.5 cm. and 13 cm. from the poll the sides are slightly constricted ('waisted') due to increased bruising, but these constrictions are so slight that they do not make it necessary to call this axe a 'waisted blade'. The implement is asymmetrically bevelled (i.e. adze-style) but the bevels are not clearly differentiated from the faces. The cutting edge is c. 28 mm. long, straight when viewed end-on, but convex and worn obliquely when viewed from the face. It is fairly blunt.

ii) Bragge's trench (Fig. 5.9a). A short axe, sub-triangular in shape, made of slaty-schist containing mica and hornblende crystals. It is ground all over one face and over half the other, from the butt end of which a large flake has been removed. In cross section the axe is a flat lens, with thin sides barely differentiated from the faces. The maximum width is at the cutting edge. The butt is rounded in plan. The bevels are nearly symmetrical and there is no sharp division between bevels and faces. The cutting edge is 40.5 mm. long, slightly convex when viewed in plan and with a sharp corner between cutting edge and side. When looked at end-on it is straight but skewed slightly to the main plane of the implement.

¹ This and other geological identifications were made by Mr C.A. Key, Dept. of Anthropology, Australian National University.

iii) Bragge's axe. This is the cutting edge and part of a blade of a lenticular-sectioned axe-adze made of hornfels. It is ground all over both faces and sides. The cutting edge is the widest part to survive; it is symmetrically convex in plan and there is no sharp corner between it and the sides. The implement is bevelled asymmetrically (max. widths of bevels 0.9 and 0.6 cm), but the edge is straight when viewed from the side or end-on.

iv) C4/(2).¹ The chip (2 x 1.5 x 0.2 cm) is of green hornfels and is ground on one side.

Table 5.6 : Measurements of axe-adzes

Number	Length cm.	Max. width cm.	Max. thickness cm.
i)	18.5	4.6	3.5
ii)	5.3	4.05	1.05
iii)	(6.4)	(5.3)	(1.65)

2) Small ground stone artefacts

Four small ground artefacts deserve separate description as they may prove to be culturally more diagnostic than more common pieces. Two of these come from HI and two from unstratified contexts.

Horizon I:

(i) C4/(4) is a bead or button in limestone (Fig. 5.7i). It appears to have been nearly circular (one side

¹

This numbering refers to square/(spit).

is partly broken off) with a diameter of 23 mm. The cross-section is plano-convex, with the convex side possibly having a slight use-gloss. Maximum thickness is 3.4 mm. A hole, diam. 2 mm., has been worked from both faces through the centre, the width of the hole at each face being 5 mm. Two slight scratches in the hole suggest that a drill was used.

(ii) F3/(2) is a smooth, solid, regular calcite cylinder, length 16 mm., max. diam. 4.5 mm. No marks of working are visible under a 10x lens.

Unstratified:

(iii) A solid, smooth, calcite cylinder tapering to a point (Fig. 5.7g). Length 32.5 mm., max. diam. 4.5 mm. No signs of working are visible under a 10x lens.

(iv) A solid cylinder of very dark blue hornfels ground in eight planes around the cylinder and with one end slightly tapered and smoothed off (Fig. 5.7e). The other end is broken. Length 21.5 mm., diam. 3.2-3.6 mm. The very marked traces of grinding show that the original shaping was at right angles to the length, but superimposed fine grinding scratches run both around and along the cylinder.

Tairora men from Himarata claimed that the tapered calcite cylinder would have been worn through the septum, and only one end was ever pointed. This was said to be characteristic of stone nose ornaments in this area. A biconical calcite nose-piece is recorded from the Telefomin area.¹

¹

B. Craig collection, Australian Museum, not accessioned when inspected.

3) Bone artefacts

Fifteen bone artefacts were found, of which six came from unstratified contexts.

All the bone artefacts are points, but only two of them are clearly whole. Of these one is a bone awl and the other a double point (bipoint).

Three classes of points are suggested on the basis of size and shape, though the numbers are insufficient for any real analysis. The classes are:

1. broad heavy points,
2. thin medium points,
3. fine points.

The distribution of these classes by horizons is set out in Table 5.7.

Table 5.7 : Bone tools - distribution

	HI	HII	HIII	HIV	Unstratified	Total
Class 1	1	1	1	-	1	4
2	1	-	2	-	3	6
3	1	-	-	1	1	3
Bipoint	-	1	-	-	-	1
Awl	-	-	-	-	1	1
	3	2	3	1	6	15

Bone awl (Fig. 5.7a)

A complete awl made from a ?tibia with an unfused epiphysis. The other end is sharpened by longitudinal

grinding to a medium point. A high gloss can be seen over three-quarters of the length of the tool, with the head being unpolished. The point is very similar to class 2 points (below). Length 91.5 mm., cross-section 10 mm. from the tip 2 x 2.5 mm.

Bipoint (Fig. 5.7b)

Made from a longitudinal splinter of long-bone shaft, one point of this artefact is broad and slightly rounded. At 8 mm. from the other end there is a slight indentation on each side as if to hold a lashing. The bone is highly mineralised. There is no record of bone points of this type being used recently in this area. Length 51 mm., max. width 11.5 mm.

1. Broad, heavy points¹ (Fig. 5.7f).

These comprise three points of oval cross-section where the point has been formed by abruptly cutting down each side. The narrowing of the point starts within 1 cm. of the end of the tool. Also included in this class is one D-sectioned tool with a broken tip (E3/(9)). Two shavings of bone have been removed from the convex side of this point.

2. Thin medium points¹ (Fig. 5.7c).

Three of the five whole points are quite round and sharp while two are slightly flat on one side. One point is broken at the tip, but clearly belongs to this class. All are very similar to the tip of the bone awl.

¹ Measurements are given in Table 5.8.

3. Fine points¹ (Fig. 5.7d).

Two are pointed sections of a flat piece of bone, perhaps a shaft fragment. The other (E4/(2)) is a very fine rounded point. All these tools are too fine to be incorporated into the other classes of bone tools, but seem rather coarser than such needles as I have observed in this area today.

Boar's tusk

Although it is unworked, the lower right canine of a pig is recorded here since these teeth are used for ornaments today. Parts of the tusk were found in unstratified contexts and the top of HI.

Table 5.8 : Bone tools - measurements

Class	Number	Horizon	Length (mm.)	Cross-section in mm. at 10 mm. from point
1	E4/(7)	II	24.0	2.7 x 5.2
1	D4/(3)	I	23.0	2.6 x 4.2
1	D5/(1)	x	28.5	2.6 x 5
1	E3/(9)	III	(22.5)	?
2	C3/ (surface)	x	21.0	3 x 2
2	D5/(1)	x	29.5	3.5 x 2.5
2	Surface	x	15.5	3.5 x 2.4
2	C4/(3)	I	25.0	?(broken)
2	E4/(9)	III	35.0	3.2 x 2
2	F3/(4)	III	14.0	3.6 x 2.5
3	E3/(1)	x	16.0	2.5 x 1.5
3	E4/(2)	I	16.0	1.6 x 1.6
3	E3/(15)	IV	24.0	3.5 x 1.2

¹ Measurements are given in Table 5.8.

4) Shell artefacts

Four shell artefacts were found, three of them in Bragge's trench.

Two of these are round button-like objects with a hole drilled from one side through the centre (Fig. 5.7j). One is 10 mm. diam. and 3 mm. thick. The third is a round hollow tube of shell 12 mm. long and 3 mm. diam. It is probably a dentalium shell and therefore a natural cylinder. The ends are slightly rounded. These three may well be beads of some sort.

The fourth artefact, D4/(4) from HI (Fig. 5.7h), is a thin rectangular piece of shell, slightly curved in one plane so that one side is convex and the other concave. Dimensions are 18 x 2 x 3.5 mm. Near one end a very small hole has been worked from one face to the other by drilling from both sides. The biconical hole and the irregular scratches within it suggest that some form of rotating hand-drill was used.¹ All corners are rounded. The end nearer the hole exhibits faint saw marks across one face, while the other end is irregularly snapped.

5) Ochre and ochre knife

Scattered lumps of red ochre (iron oxide) were found throughout the site. Most of the lumps weighed under 7 grams, though three weighed over 10 gm. Four lumps show signs of scratching or rubbing.

¹

See Semenov, 1964, pp.74-83; flint flakes used for drilling are described from Lake Kutubu by F.E. Williams, 'Natives of Lake Kutubu, Papua', Oceania Monographs, 6, 1941, p.28.

Table 5.9 : Ochre

Horizon	Wgt in gm.	Gm./cu. m.
I	32.1	17.8
II	50.2	45.5
III	6.7	6.7
IV	26.4	14.8
Unstratified	25.8	-

We do not know when or if the ochre in the site was used for the rock paintings. It may well have been used for body or artefact-painting.

A short heavy flake with ochre along both sides of one straight edge was discovered in Horizon II at the back of the cave. The ochre is dark red and is concentrated on one side of the edge. Close inspection of the ochre smears shows that the edge was used for cutting or shaving ochre, perhaps into powder for use as paint. A few slight signs of use-wear can also be seen on the edge.

The dimensions of the flake are 33 x 26 x 16 mm. and the angle of the cutting edge averages 50°.

4. Flaked stone artefacts

1) Waste material

Over 17,000 primary flakes and core-lumps showing no traces of secondary working or use were recovered. Most of these are flakes produced and discarded during the manufacture of implements. If any have been used as implements they show no macroscopic traces of this.

Waste material is in a fairly constant ratio to implements of just under 30:1, showing that knapping was regularly carried on at the site¹ (Table 5.10).

The material is nearly all greasy chert, although there is a wide variety of colours and textures. Four pieces of obsidian were found towards the front of the cave in Horizon I. The main sources of chert are not definitely known, but local informants said that they were several miles away up-river. There appear to be no sources near the site.

A size analysis in terms of the description given above (Chapter 3), suggests that waste material in the basal horizon is rather larger than it is in the other three horizons (Tables 5.11, 5.12).

2) Hammers

Three river pebbles showing traces of use as hammers were recovered, one from Horizon III and two from Horizon IV. The latter two are both broken pebbles and it is not clear whether they were used as hammers before or after being broken. Measurements are given in Table 5.13.

¹ Cf. J.D.G. Clark, 1954, p.96; R.R. Inskip, 'A Late Stone Age Camping-Site in the Upper Zambezi Valley', South African Archaeological Bulletin, 14 (55), 1959, pp.91-6.

Table 4.10 - Waste material - number of blocks

Square	Horizon				Total
	I	II	III	IV	
C3	123	294	147	-	564
C4	214	495	248	-	957
D3	1011	994	305	21	2431
D4	285	802	990	296	2473
E3	1222	905	1251	1701	3079
E4	650	849	1216	1392	4107
F3	234	399	757	198	1588
Total	3839	4718	5114	2508	17179
Ratio waste blocks/impement	28.0	32.3	27.2	28.4	27.9
Number/cw. metre	1920	4229	5114	1551	2910

Table 4.11 - Waste material - size [Per cent]

Size	mm ²	Horizon I		Horizon IV	
		Sample 1	Sample 2	Sample 1	Sample 2
< 1/2	< 160	73	57	57	38
1/2 - 1	160-630	25	18	28	46.5
1 - 1 1/2	630-1450	1.8	5	4	11.5
1 1/2 - 2	1450-2600	0.2	-	1	3
> 2	> 2600	-	-	0.2	2
Total number		285	247	363	238

Table 5.12 : Waste material - weight in gm.

Square	Horizon				Total
	I	II	III	IV	
C3	137.7	365.2	199.7	x	702.6
C4	420.3	1104.2	527.4	x	2051.9
D3	933.6	974.7	505.4	80.7	2494.4
D4	367.6	532.6	908.9	946.2	2755.3
E3	822.5	555.6	765.4	2301.5	4445.0
E4	620.5	396.4	853.3	1530.8	3401.0
F3	473.9	726.6	908.3	447.0	2555.8
Total	3776.1	4655.3	4668.4	5306.2	18406.0
Mean wgt of waste material (gm.)	0.99	0.99	0.91	1.51	1.07
Weight of waste (gm.) per cu. metre	2097.8	4232.0	4668.4	2947.9	3119.6

Table 5.13 : Hammers

Reference ¹	Horizon	Material	Wgt (gm.)
39.E4/(9)	III	Hornblende-porphyry	480.6
97.E3/(11)	IV	Porphyry	125.9
116.E3/(13)	IV	Porphyry + pyrite crystals	171.1

The absence of hammer stones from the upper levels of the site may mean either that they were deposited in other parts of the site, or that chert pebbles, originally used as hammers, were later used as cores or implements, and cannot therefore be recognised as hammers now.

The porphyritic rocks used are dense and not brittle. They tend to bruise rather than fracture owing to the presence of large soft crystals in a dense ground matrix. This is probably why they were chosen for use as hammers.

3) Trimming flakes (Fig. 5.9b)

Trimming flakes are a constant component of the industry and there is an average of one for every two flaked implements (Table 5.14). It is interesting that the ratio of implements to trimming flakes increases from 1.85 to 2.63 from the lowest to the topmost horizon. This suggests that implements were re-trimmed less frequently as time went on.

¹ Note that numbers given in this form refer to 'catalogue number.square/(spit)'¹.

Table 5.14 : Trimming flakes - number

Square	Horizon				Total
	I	II	III	IV	
C3	1	10	5	-	16
C4	3	13	12	-	28
D3	17	16	9	-	42
D4	1	3	15	4	23
E3	11	18	32	43	104
E4	15	7	18	27	67
F3	4	5	10	4	23
Total	52	72	101	78	303
Ratio of implements to trimming flakes	2.63	2.03	1.78	1.85	2.03

4) Joins

Ten pairs of flakes or implements which had been broken in antiquity were joined together. Seven of these were pairs from the same square metre and excavated level, and a further two came from adjacent levels. The tenth came from two levels separated by 20-30 cm., belonging to Horizons I and III. This suggests that this deposit was subject to some treading and scuffage. It also reinforces the point that the horizons probably do no more than separate the archaeological material into groups most of whose members are in the correct stratigraphic relationship.

5) Flaked stone tools (Figs 5.9c, 5.10-5.13; Plates 5-7--5-9)

A total of 615 pieces of stone with secondary retouch or use-wear was excavated from the undisturbed levels of Batari.

The implements were distributed in approximately equal numbers between the four horizons. Their density per cubic metre of deposit is therefore higher in Horizon II and Horizon III than at the top and base of the site.

Table 5.15 : Implement distribution

Horizon	No. of implements	No./cu. m. deposit
I	137	76
II	146	132.8
III	188	188
IV	144	80
Total	615	108

These tools have been analysed according to both the standard typology and the 'edge analysis'.

According to the standard typology the tools may be generally described as simple and multiplatform scrapers mostly made on flakes. Some are cores later modified into scrapers, which accounts for the low number of simple cores in this analysis. The retouched edges are mostly concave in shape, some being quite deep, but there is a complete range from straight to concave edges and no group of deeply notched pieces can be isolated.¹

A clear division is made between single and multiplatform tools. Most multiplatform tools have been used as cores though they have also been retouched as scrapers. It is noticeable that they become a less important component in the industry in more recent times. This parallels the shift away from the concentrated use of tools which has been seen in relation to the trimming flakes; there are however no other signs of this (e.g. increase in the number of flakes per retouched piece).

The single platform tools have been divided into classes. This is clearly an arbitrary division, since the amount of retouch is widely variable, ranging from almost none to 'discoid' scrapers retouched round most of their margin. There does not seem to be any shift in the representation of each class per horizon.

Table 5.16 sets out the occurrence of tools at Batari according to the standard typology. Some comments on the tools from each horizon follow:

¹ This has been tested by a series of measurements of the edges.

Horizon I: Most tools are on flakes and none are large. One is made on a piece of obsidian and appears to be heavily used. Two of the 'discoid' scrapers are simply flat flakes with steep retouch round most of the dorsal surface while two are chunky pieces with bulbs removed.

Horizon II: The notable tools are three double concave scrapers (Fig. 5.10a). These have a long (1.5-2 cm.), thin (<1 cm.), ridged projection which juts out from between two deeply retouched concavities. On these small artefacts the effect of this is very striking.

In three side and end scrapers the junction between side and end is marked by a slight, unretouched projection.

Among the single platform tools there are a few deeply concave edges measuring around 20 x 3 mm.

Horizon III: Of the double concave scrapers only one is well defined and this has retouch all round the base. In the other two the projecting ridge is not well marked.

The side and end scrapers tend to grade into the 'discoid' group which in this horizon are small (<2.5 cm. diam.) and chunky.

The ?bifacial is very lightly retouched along one side of a flake, small scalar flakes being detached from both faces of this edge.

Horizon IV: A few tools from this horizon are larger including one end-scraper on a large chunky flake (7 x 5 x 4 cm.) and a very large flake (8 x 7.5 x 3 cm.) in grey, non-greasy chert retouched around one end, with pebble cortex on the dorsal surface. This is the closest thing to a pebble tool found at Batari, since it weighs 263 gm.

Twelve of the multiplatform tools are very small (ca. 2 cm. cube) and chunky. At least 8 have been cores. They are notable for their generally complex configuration and small size, and are spread throughout the horizon. Another multiplatform tool is a double concave scraper in one plane, but is also heavily inversely retouched at the other end (Fig. 5.9c).

Two side scrapers have very large retouched concavities both being ca. 35 x 10 mm.

As well as this analysis an 'edge analysis' of 614 pieces was carried out according to the method described in Ch. 3.¹ One implement, a multiplatform tool without pebble cortex from Horizon II, had 14 edges on two planes and could not be analysed.

This analysis is divided into five sections. The numerical tables will be found in Vol. 2.

A. Description of the implements, treating each stone implement as a unit.

B. Description of the implements using the edge as the basic unit. Therefore when two edges occur on an implement any measurements or observations on that implement will be duplicated.

C. Description of the edges in terms of size, shape, retouch, utilisation and so on.

D. Particular correlations between some attributes.

¹ The IBM cards, data sheets and computer output have been deposited with the Dept. of Anthropology, Australian National University.

Table 5.16 : Tool Types - Number

	Horizon				Total
	I	II	III	IV	
1. Total tools	137	146	188	144	615
2. Whole retouched tools	32	51	63	44	190
3. 2 as % of 1	23.4%	34.9%	33.5%	30.6%	30.9%
4. Utilised pieces	22	23	20	29	94
5. 4 as % of 1	16.1%	15.7%	10.6%	20.2%	15.3%
6. Cores	6	4	2	2	14
7. Scrapers - total	32	51	62	44	189
- side	7	12	12	10	41
- end	3	3	8	4	18
- double side	4	3	7	3	17
- side and end	4	10	6	3	23
- side and double end	1	1	-	1	3
- discoid	4	-	3	3	10
- double concave	-	3	3	-	6
- multiplatform	9	19	23	20	71
8. 8 as % of 7 (total)	28.1%	37.2%	37.1%	45.4%	37.6%
9. Bifacial retouch/use	-	-	1	-	1
10. Broken tools	77	68	102	69	316
11. 11 as % of 1	56.2%	45.6%	53.2%	47.9%	51.4%

E. Attempts to define 'types'.

A. The analyses in this section refer to each stone implement as one unit.

i) Type of stone used: The industry is made almost entirely in greasy chert, only 2.1-4.8 per cent of all retouched or used stone being in other material.

ii) Number of planes/implement: In all horizons, between 2/3 and 3/4 of all implements are used on one plane only (Table 1). The 20-30 per cent of implements used in more than one plane are a significant demonstration of the lack of formal orientation of implements in this industry.

iii) Number of edges/implement: One half to 2/3 of the implements have one or two edges as defined in Chapter 3, and few have more than 3 edges/implement (Table 2). The mean number of edges/implement for the site is about 2.6 and this does not vary widely between the four horizons. It seems that most implements were used or reshaped more than once.

iv) Weight of implements: Table 3 sets out the range of weights of all implements in each horizon. Inspection suggests that there is no real difference between the horizons, except that there seem to be fewer tools weighing more than 10 gms in the top horizon. Comparing the distribution of weights in HI and HIV $\chi^2 = 5.30$ with 4 degrees of freedom, which is not significant. This suggests that the difference is probably not archaeologically important.

When the implements used on one and two planes are weighed separately (Tables 4) it is seen that implements used on two planes are heavier than those used on one plane. Similarly implements with more than two edges tend to weigh more than implements with one or two edges (Tables 5). Thus implements with more planes and edges are not more 'worked out' and smaller than those with fewer planes and edges; rather they have been made on larger stones giving the opportunity for more planes and edges to be used. This argument assumes that there are equal proportions of broken implements in each group. The assumption cannot be tested since numbers are too small, but its validity seems to be supported by Table 6.

v) Edges: A total of 1,598 edges were observed on the 615 stone implements in the industry. By horizons, the numbers are:

Horizon	Number	Mean no./implement
I	381	2.78
II	325	2.22
III	477	2.54
IV	415	2.88

B. In the following analyses the edge is used as the basic unit. Therefore if two edges occur on an implement any measurements or observations on that implement will be duplicated.

i) Whole implements: Only 7-10 per cent of the edges are made on implements which can definitely be

called whole in relation to that particular edge, and only a further 11-14 per cent of the stones are even probably whole. With two-thirds of all edges it is unclear whether the implement is, for that edge, whole or not whole (Table 6).

ii) Raw material: About a third of the industry is made on stones with pebble cortex, and another quarter of the edges are made on stones with some sort of cortex (Tables 7). These figures are relevant to the discussion of pebble tools (q.v.). It is clear that a large proportion of tools at Batari were always made on river pebbles. The number of tools with pebble cortex is of course only a minimum indication of the amount of the industry which is actually made on river pebbles, since any tool without cortex may have been made from a river pebble.

iii) Size and shape of implements:

Weight. Tables 8 show the weights of implements taking each edge as a separate unit, so that if an implement carries three edges its weight is counted three times. It is noticeable that 'not whole' implements weigh much less than 'whole' implements, but 'probably whole' implements weigh significantly more.¹ This suggests that probably whole implements are likely to be whole, so that at least one-fifth of the edges are made on implements which can be shown to have been unmodified since that edge was used.

¹ $\chi^2 = 22.09$ with 4 degrees of freedom. When $P = 0.05$, $n = 4$, then $\chi^2 = 9.49$.

Shape. Implements are oriented for measuring by placing the base down and attempting to fit the stone into the smallest containing rectangle (see Ch. 3). Tables 9 express the shapes of implements which are clearly whole in relation to a particular edge; Tables 10 for all implements not clearly broken. These tables show a marked consistency in the shape of implements throughout the deposit. The L/B index shows that very few have a length more than 2 x breadth and about 60 per cent are close to a square. The chunkiness of the industry is also expressed by the B/Th. index (Tab. 10(b)) which shows that breadth is less than 2 x thickness in over half the industry. The somewhat different picture given by Table 9(b) may be a function of the small numbers; it may also be related to the fact that it is rather easier to assess whether a thin flake is whole than it is to assess the same for a core or lump, which is usually chunky.

iv) Flakes and cores: About half the edges are made on definite flakes, while only a third or less are made on cores, lumps and chunks (Table 11). In this respect it could be said that the industry is primarily based on flakes. However if the ratio of flakes to cores, lumps, etc. which result from any normal attempt to flake stone is assessed¹ it suggests that cores and lumps are being selected for this industry. It seems likely that the selection of a stone for an implement depended more on features such as suitability of edge, ease of holding the

¹ J.D.G. Clark, 1954, p.96. At Star Carr the ratio of waste to artefacts was 66:1.

stone and so on, rather than whether it was a core or a flake.

C. The following attributes describe the edges in terms of size, shape, retouch and so on.

i) Whole/not whole: Almost exactly two-thirds of the edges are either whole or probably whole, and this figure is highly consistent throughout the site (Table 12). There is however, a regular decrease in the percentage of clearly whole edges and an inversely related increase in the percentage of 'probably whole' edges from base to top of the site. This is hardly likely to be an observer-induced change, but it is difficult to suggest any archaeological explanation for it. It may relate to some feature of the flaking patterns which has not been explicitly observed, such as the contiguousness of multiple edges on an implement. However, its chances of being a significant diagnostic feature seem to be remote since it is difficult to make an objective assessment of the 'probably whole' category.

ii) Base type: There is a range of surfaces used as bases, but there is a clear selection of positive bulb surfaces which form nearly half the bases. A further quarter are negative bulb surfaces (Table 13). This implies a certain preparation of material for use as tools beyond simply breaking a chunk of chert and using the broken or cortex surface as the base. It is also consistent with the high percentage of the industry which is made on flakes.

iii) Preparatory flaking: About half the edges for which this category is determinable and relevant are

prepared for use by the removal of one or more large flakes struck from the base. Almost none of the preparatory flaking is from any other point on the surface. About one quarter of the edges are not prepared (Table 14).

iv) Shape of edge: Among edges which are clearly whole there is a fairly consistent pattern of shape, with two-thirds or more being concave to some extent (Table 15(a)). This confirms the original impression of the industry as comprising mostly worked notches.

It is apparent that there are rather more straight edges among the 'probably whole' edges (Table 15(b)); this might suggest that some of these (?10 per cent or so) are in fact broken at one end, resulting in their being straightened out.

The shape of edges has been measured as the length of the chord (L_c) and the maximum distance of the edge from the chord taken at right angles from it (D). L_c is a measure of the size of the edge and L_c/D is an index of its indentation or projection. L_c/D is always 0 for straight edges.

Among the whole edges, concave edges tend to be longer than straight ones throughout the site (Tables 16(a)-(b)).¹ The majority of all whole edges is less than 10 mm. long.

The indentation index remains very stable over the whole site with nearly two-thirds of all whole concave

¹ Table 16(c) gives the data for convex edges but there are too few of them to allow comment.

edges having an index of 5-9.9 (Table 17). Too few whole convex edges occur for this index to be measured on them. If all edges are considered excluding only those that are clearly not whole, convex edges are seen to diverge less from a straight line than concave edges (Tables 18).

v) Retouch: Step flaking accounts for over 90 per cent of all retouch in all horizons. About two-thirds of all edges are step-flaked and most other edges are not retouched at all (Table 19).

Most step-flaking is found on concave edges and almost none is found on convex edges (Tables 26(b)-(c)). Light step flaking is less restricted to concave edges than heavy step flaking.

Fifteen edges in the site incorporate two types of retouch, usually light and heavy step flaking.

Nearly all step-flaked edges are acute angles with a mode at $60-79^{\circ}$ (Tables 20(a)-(b)). The very few edges with other unifacial flaking seem to have slightly more acute angles (Table 20(c)). It is interesting that an early impression of the industry as consisting of right-angled to obtuse edges is not confirmed.

vi) Utilisation: About half the edges show use-wear of the 'chattering' type and a further 10 per cent are 'utilised' (Table 21). Most of the rest show no signs of use.

Thirty-eight edges scattered through the horizons show use-wear in two places. Normally both pieces of use-wear are 'chattering'.

Use-wear mostly forms a straight line along an edge: only 1/3 of all lengths of 'chattering' and 1/4 of all lengths of 'utilisation' are concave (Tables 22). Almost no 'chattering' is convex, which confirms the relationship between 'chattering' and step-flaking. If only whole lengths of use-wear are considered, the relationship is even more accentuated (Tables 23). There is clearly an increase in straight 'chattering' towards the top of the site.

The normal length of use-wear is under 10 mm. There is a clear suggestion that 'utilisation' tends to be longer than 'chattering', with lengths up to 20 mm. being common, whereas almost no 'chattering' is longer than 10 mm. (Tables 24).

Where the use-wear is concave the two main types are clearly distinguished by the indentation index, with 'utilisation' being much less indented than 'chattering' (Tables 25, 27(a)-(b)). Such a distinction is not visible with convex use-wear, although the numbers are probably too small to bring it out (Tables 28).

Nearly all use-wear is on acute angled edges. The mode for 'chattering' is 70-79° while the mode for 'utilisation' is 50-59° (Tables 29). This difference probably relates to different uses of the tools. It is interesting that if all the angles from any one horizon are considered without reference to the type of use-wear they are distributed in a unimodal curve. Furthermore, there is no change in the curves between the top and basal horizons, confirming the technological and functional similarity of this industry (Fig. 5.6).

HI Mean of all angles 68.31° , with S.D. 16.11
 HIV Mean of all angles 67.44° , with S.D. 16.44

A χ^2 test¹ confirms that there is no significant difference between these horizons.

It is remarkable that many units of use-wear are straight when the common shape of a retouched edge is concave. It suggests that in many cases only part of what is usually called a functional edge is actually used at any time. It also suggests that the 'notches' in any industry may result from continual retouching of an edge rather than from any initial functional requirement. The presence of 'notches' may therefore stem from the kinematics of using and retouching these tools. For instance, it is probably simpler or more convenient to hold a tool in a particular way, thus tending to bring a certain point into wear more frequently. Similarly, once a 'notch' has been started in any way it is probably continued for the same reasons.

D. Correlations between attributes.

Several questions were asked to show the degree of relationship of certain attributes. Some of the answers showed no more than may be readily inferred from the previous descriptions, but it seems useful to draw attention to three important correlations.

1) Retouch and use-wear: Preliminary handling of the industry suggested that 'chattering' was concentrated on step-flaked edges. This is not quite accurate as only

¹ $\chi^2 = 9.38$ with 7 degrees of freedom.

two-thirds of all 'chattering' is found on step-flaked edges (Table 30(a)); the reverse, however, is true - the use-wear on step-flaked edges is nearly all 'chattering' (Tables 31(a)-(b)). Two-thirds of all use-wear on unretouched edges is 'chattering' (Table 31(c)), but nearly all 'utilisation' is found on unretouched edges (Table 30(b)).

ii) Retouch and 'chunkiness': There is a definite, if slight, tendency for edges without retouch to occur on thinner implements than edges with step-flaking (Tables 32). This does not show up when retouch type is related to the Breadth/Thickness index (Tables 33).

iii) Size of implement and angle of retouch: There is no clear relationship between the weight of an implement and the angle of retouch on it. For implements with light or heavy step flaking there are the same range of preferred weights and angles, especially 10-19 gm. and 60-79°, and these do not form sharply defined units (Tables 34).¹

E. Attempts to define 'types'.

The most interesting aspect of this industry is the apparent stability of all its features throughout the entire period of occupation. This might be expected in features which relate directly to tasks, such as the shape and size of use-wear, but it is less likely to occur in features which are not so directly related to technical necessities, like the shape and size of implements.

¹ Since these tables exclude all 'not whole' implements the distribution of features is slightly different to Tables 20 and 5, but the focus remains the same.

Before the implements were described it was apparent that formal types were not easily definable: it is not unexpected therefore that they remain fugitive. There do however seem to be at least two clusters of attributes which may begin to define 'types'. The clearest division in the tables so far is between the two types of use-wear - 'chattering' and 'utilisation' (Tables 29). Edges with these two types of wear have therefore been made the basis for further study. One difficulty has been that the number of 'utilised' edges is quite small so that precise results are more difficult to obtain.

It is already clear that units of 'chattering' and 'utilisation' tend to have different angles (Tables 29) and that the former is often associated with step-flaking retouch (Tables 30). It can also be shown that the shape and length of these types of use-wear are different (Tables 35, 36) while the length and shape of the edge on which they are found is also likely to be different (Tables 37, 38). 'Utilised' edges do not carry preparatory flaking (Table 39) and they are much more likely to be made on flakes than are edges with 'chattering' (Table 40). Further, the implements themselves differ in thickness and weight, with 'utilised' edges being on thinner, lighter implements (Tables 41, 42).

The associations outlined here do suggest that there is a difference, possibly a functional one, between two groups of tools.

A further attempt at characterising tool groups has been made by investigating the properties of retouched and unretouched edges with 'chattering'. It will be seen from

the tables that although there are suggestions that these two groups differ this is far less marked than the division based on use-wear groups.

There is a slight but consistent difference in the angle of use-wear (Table 43). The shape of use-wear fluctuates widely (Tables 44) and 'chattering' found on unretouched edges tends to be a little longer (Tables 45). Preparatory flaking is more likely to be associated with retouch than with lack of it (Tables 46), but almost precisely the same numbers are made on flakes and core/lumps (Tables 47). The implements without retouch tend to be slightly lighter and thinner than those which are step-flaked (Tables 48, 49).

Whether these differences are sufficient to allow two 'types' to be defined will be a matter for discussion, but there is at least a suggestion that this is so.

It should be noted in passing that the shape of 'chattering' on step-flaked edges changes very markedly through the four horizons. The reasons for this are not clear, but they may have to do either with changing methods of using tools or with a changing pattern of manufacture during the history of the site.

Another method of making these types more explicit - and one which ignores any influences of temporal change - is to combine the data from all four horizons in order to characterise each type. Tables 50-59 set out the results of doing this. The information from these tables adds little to deductions made earlier, but three features emerge clearly.

One is that the three groups (edges with 'chattering', with 'chattering' without step-flaking, and 'utilisation') are distinguishable, particularly by the distribution of their weights, with the less retouched implements being lighter. This weight pattern is not entirely correlated with variations in thickness.

The second criterion is that shapes of edges vary in a way use-wear shapes do not seem to. Three quarters of all step-flaked and 'chattered' edges are concave, but only half the unretouched 'chattered' edges are this shape. At least one quarter of 'utilised' edges are convex.

The third feature is that half the 'chattered' edges are less than 5 mm. long, whether they are associated with retouch or not. Only 7 per cent of 'utilised' edges are so short.

Summary

Whether these 'types' can be shown to be coherent and consistent even in this part of New Guinea will, at least in part, determine their validity. All that can be claimed here is that there do seem to be some different morphological features associated with some observations to which a functional interpretation has been given. The basis on which these 'types' have been constructed has been made explicit to try and minimise, or at least assess, the subjective element.

5. Conclusions (Fig. 11.3)

The period at which Batari was first occupied is unknown. ANU-40 suggests it may have been 16,000 years ago or more: in terms of the stratigraphic location here and dated occurrence elsewhere in the Highlands of ground axes, grooved and ground artefacts, marine shell and pigs this is a possible date. It might be expected however that the proportions of various wild animals hunted and perhaps also the retouched implements would show some changes between earlier and later levels if the early date were correct. I predicted, in fact, before ANU-38 was available, that one might expect the earlier occupation of this site to occur from 3,000-8,000 years ago. ANU-38 supports this. It may be suggested that sampling error or local differences account for some absences among the implements in the lower levels.

The earlier occupants of the site left only limited material, in the form of flaked stone tools and animal bones. Only wild animals were eaten then, and we may assume they were hunted with weapons made by the stone tools found on the site. The middle levels of occupation show little change: very similar retouched tools, though in larger numbers, continue to be found, while the same animal species were brought back and eaten.

It is only within the upper level, perhaps within the last 3,000 years or so, that different tools are found - axe-adzes, grooved and ground stone and bone artefacts. Marine shell was also traded into the site. Stone-knapping continued to occur though, and as in earlier times, suitable chert had to be bought from some distance. Pigs began to

supplement the wild meat part of the diet, but there is no evidence about the other types of food eaten.

Throughout the history of Batari the confined dry space of the occupied area was subject to a good deal of treadage and scuffage so that features in the deposit, such as hearths, were obscured.

Some 750-1000 years ago some very large fires were lit in the cave, which then seems to have been largely abandoned, although later occupation may have been obscured in the very soft topmost level. Even around the time the fires were lit, however, owl pellets show that the human occupation was sporadic.

Generally speaking, the artefacts from Batari show a greater similarity with Aibura than with other sites. The retouched implements are similar to those found at Aibura below levels dated to 770±110, while the presence of small grooved and ground stone and shell artefacts also links the two sites. The absence of waisted blades, quadrangular axe-adzes, pebble tools and tools with use-polish is probably also significant and may point to an eastern regional aspect of the Highlands industries.

There is no sign at Batari of change either in the flaked implements or in the environment in which wild animals were hunted. This suggests that there was no sudden increase in the area of grasslands down to ca.1000 years ago - or that most hunting was always done in the forest.

CHAPTER 6

EXCAVATIONS AT AIBURA, LAMARI R. VALLEY1. Introduction¹

Aibura² is the name given by Tairora of Barabuna village to a small free-standing block of Tertiary limestone which lies 12 miles on a bearing of 195° from Kainantu at an altitude of ca. 5,300 ft M.S.L. (145° 57'E Long., 6° 26'S Lat.) (Map 2). This block rises out of a small swampy valley draining into the Kondanauta Creek, a small west-flowing tributary of the Lamari River (Fig. 6.1). The valley floor, in which many old garden ditches occur, is now covered with pitpit (Phragmites karka and Saccharum sp.). On the slopes around grow shorter grasses such as Imperata cylindrica. The topography is rolling rather than steep by New Guinea standards, with many swampy patches in the river valleys. The lower levels are all grassed with a few trees close to water courses; good stands of rain forest occur on all surrounding peaks (Plate 6-1).

The block itself is small (ca. 60 x 25 x 15 m.) and well covered with trees and creepers (Plate 6-2). Its outer surface is highly irregular. It is aligned

¹ I am grateful to Mr J.N. Jennings for discussing aspects of the geology with me.

² Reference number A64.

approximately NW-SE and its interior is hollow, forming a cave which stretches the length of the block (Fig. 6.2).

The cave may be divided into four chambers. The north-western half is a very dark tunnel with 1-2 m. headroom and a flat floor. This leads to the main chamber, approx. 15 x 10 m., which is lit by a few small holes in the roof and some light entering from the large southern entrance. The light is never strong enough for unaided photography. There are a few stalactites and stalagmites around the edges of this chamber, but the floor is flat and the headroom is 3-4 m. (Plate 6-3). Next there is the southern chamber where the floor is formed by a natural talus slope from the two entrances. The small eastern chamber also has two entrances and an irregular floor; access to it from the main chamber is difficult because of stalagmites. There is still active deposition in the cave, with small patches of stalagmitic concretion being formed on the present floor. There are not many water-drips in the dry season, but the floor is very damp and floor wash apparently occurs in the wet season.

Aibura appears to be an isolated limestone relict of the Omara Greywacke¹ which is common in the Lamari headwaters area. It was clearly formed by water and possibly by riverine action. Its origin may have been as part of a much larger cave system, most of which was later removed by dissolution. This is supported by the way in which water action is clearly eroding the roof of Aibura today.

¹

Dow and Plane, 1965, pp.8-12 and Plate 5.

Discovery and Excavation

Aibura was first visited by Mr A Vincent¹ in 1961 and reported to Dr V. Watson who was recording archaeological data as part of the University of Washington Microevolution Project.² Dr Watson visited the cave and picked up two large step-flaked tools.³ In April 1964 she told me of the cave and suggested it would prove a good place to work. On 16 April 1964 I excavated a 1.2 x 1 m. pit to a depth of 1.6 m. in the main chamber and found 61 flakes and lumps, including 15 retouched implements in a matrix of dark, wet silty loam.⁴ Hearths in the form of washed ash lenses were noted down to about 60 cm. and the industry seemed to be concentrated at a depth of 90-105 cm. A sterile gritty reddish layer underlay the cultural material from a depth of 1.2 m. Since the primary purpose of this pit was to see whether the site had stone artefacts in an undisturbed stratigraphic context it was dug rather quickly and the soil was not carefully sieved. The material from this pit is listed in Table 6.1; it is also included in the main analysis.

¹ Summer Institute of Linguistics, New Guinea Branch.

² Watson, 1963.

³ Kindly donated to the main Aibura collection.

⁴ For a preliminary report see White, 1965b, p.335.

Table 6.1a : Material from Test Pit

Unit	Implements	Trimming Flakes	Waste	Hammer	Other
1. 0-90 cm.	3	-	6	1	6
2. 90-105 cm.	11	1	22	-	6
3. 105-120 cm.	1	-	3	-	1
Total	15	1	31	1	13

Table 6.1b : Waste flakes - Size

Unit	>2"	2-1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ -1"	1- $\frac{1}{2}$ "	< $\frac{1}{2}$ "
1.	-	4	2	-	-
2.	1	6	12	3	-
3.	1	1	1	-	-
Total	2	11	15	3	-

Aibura was one of the two promising sites located in the Lamari River valley during the first season's survey. Its excavation could provide initial information for evaluating 1) the local sequence of the Lamari valley, 2) the theories of the Microevolution Project and 3) broader theories of Highlands prehistory, by providing one end of a continuum of sites across the area.

The western part of the main chamber was therefore excavated for four weeks from 1st to 27th August, 1964.¹ A total of 15 sq. metres was removed, 12 of them as a 4 x 3 m. rectangular trench taken down to the sterile base. The three square metre extension trench showed no stratigraphic features: it therefore does not appear on the drawn sections or plans of features. The test-pit was incorporated into the main excavation. In all, about 20 cubic metres of deposit was removed, perhaps one-eighth of the archaeological deposit. Most excavation was done by the author although two Tairora youths dug for a few days under close supervision.² The site was removed in square metres consecutively numbered from the north end with Roman numerals (Fig. 6.11) and as a series of levels (spits) conforming to the pattern of ash lenses and other visible stratigraphic features. These vary from 5 to 20 cm. in depth and the levels vary accordingly, but all were roughly horizontal.

¹ For a preliminary report see J.P. White, 'Archaeological Excavations in New Guinea: An Interim Report', Journal of the Polynesian Society, 74, 1965a, pp.43-8.

² For excavation methods see Chapter 3.

Excavation of this site was hampered by the limited light in the cave and also by the author's illness. The limited light made photography difficult and faulty flash-light equipment means that fewer good photographs are available than is desirable.

Stratigraphy

a) General (Figs 6.7-6.9; Plate 6-6)

The surface of the excavated area sloped slightly towards the north with a maximum fall of 30 cm. but a mean fall of about 20 cm. The earth was very damp and dark, with a field pH of 6-8 throughout. It was already apparent from the test trench that ash lenses occurred for some 60 cm. below the surface. The main excavation showed that these lenses occurred over the whole area but were thicker in the northwestern part of the trench. They consisted largely of well-packed white to cream ash with some burnt soil and carbon. Most were almost horizontal and tended to tail out or even curve upwards slightly at the ends, as if they had been spread and slightly re-deposited by water. They occurred for about 50 cm. below surface in the east and 60 cm. below surface in the west of the trench, and were interspersed with damp blackish silt. There was a concentration of artefacts at about three-quarters of the maximum ash lens depth, while many postholes occurred in the top 35 cm. Scattered through the lenses were occasional concreted patches clearly formed by dripping water.

Below the lenses there was about 80 cm. of fine dark silt with a little grit. It appeared to have been washed free of ash lenses but a few concentrations of carbon

remained. Bone and stone artefacts were concentrated about 10-20 cm. below the ash lenses. The sterile basal deposit was a well-compacted, granular yellow-brown to grey soil with a relatively high component of grits. This deposit was cut into by a channel running approximately north through the excavation. It also dipped parallel to this channel along the west wall.

In the northeast corner of the trench there was only a thin deposit of soil below the ash lenses. Beneath this soil was a stiff, almost sterile clay. The development of this clay was fairly abrupt around most of its perimeter.

In the southwest corner of the trench, especially square \bar{X} , bedrock was found close to the surface. It sloped down steeply to north and east.

Several processes probably helped form the deposits in Aibura. The lowest sterile material is at the same level as the swamp outside the cave, and probably contains similar material with some additions of grit due to cave dissolution: it was probably shaped by water solution. The dark, wet silt above this was possibly deposited by both water and human action followed by some re-settling and washing due to water-table variations. The washing was apparently very gentle since carbon and a high component of fine soil remain. The silt is bracketed by two radiocarbon dates¹ which suggest that it accumulated over some two thousand years. The origin of the thick bank of clay remains a problem but its location is likely to represent a long-term pool. The fact that few

¹ See below, p.196.

artefacts are incorporated in the clay reinforces the suggestion that all washing within the cave was gentle.

The ash lenses are explicable as a series of occupations, partly spread and compacted by gentle water action. Most lenses have formed within the last 600-1000 years, since they lie above GaK-622.

b) Postholes, Pits and Other Features (Figs. 6.3-6.6;
Plates 6-5, 6-7)

Many postholes and a pit were found in the western half of the excavation, all within about 35 cm. of the surface. The majority of the postholes lay within 15 cm. of the surface and three clearly defined alignments were noted (Fig. 6.3). The holes of these alignments all started from the same stratigraphic level. Two of them ran almost precisely parallel with the west wall of the cave and one ran at right angles to this, at the southern end of the excavation. The largest diameter among the aligned holes was 10 cm. All posts were set vertically or dipped slightly towards the east.

Below 15 cm. depth postholes were fewer and concentrated in the northeast corner. Only one probable alignment was found, set approximately parallel to the cave's western wall (Fig. 6.4).

Most of these postholes and especially the alignments clearly record the erection of shelters within the cave. These were probably simply lines of branches staked into the ground and leaning against the wall. They may have been interwoven with brush. Villagers from Barabuna said

that this cave was used as a refuge in pre-European times, and these shelters may have been used then.¹ Temporary shelters of this kind have been seen in other rock shelters used for overnight stops south of this area.²

A large pit was also found, starting about 10 cm. below the surface. Irregular at the top it became a square with rounded corners (diam. 18 cm.) by 30 cm. below surface and maintained this shape until the rounded base was found at 75 cm. below surface. The pit was filled with loose grey ashy silt in which only one stone flake was found. At some time later a large (diam. 12 cm.) round pit or posthole was dug in the SW corner of the original pit. Neither of these holes can be associated with any other complex of postholes and the purposes for which they were dug are unclear. The pit is about the right shape and size for a small cooking pit but the absence of any heating stones makes this unlikely, although heating stones are sometimes taken away for re-use. There were no signs of extra organic material in the fill and the use of latrines is still unusual among the Tairora.

The third feature was a congregation of small limestone boulders about 25 cm. below the surface (Fig. 6.5; Plate 6-4) in square I. The trench just includes the 20 boulders, which look as if they were placed in position rather than simply dumped there. These stones are much

¹

They may have been associated with the occupation of a village about 100 m. southwest of Aibura (Fig. 6.1).

²

P.J. Thomas, Obura Patrol Post, pers. comm.

too large and of the wrong material for pit cooking. They are the wrong material for stone-working and there are no traces of this on them. They are not obviously linked with a hearth or with a particular posthole alignment though some indication of this may have been missed in the bad light. They are unlikely to be a roof-fall since in this case one would expect one big and several small rocks, all dumped in a heap.¹ There is no obvious gap in the roof at this point either. I am unable at present to suggest an explanation for this feature.

Radiocarbon dates

Two radiocarbon determinations were obtained from Gakushuin University for levels of this site.² These are:

GaK-622: square VII, level 4	770 ± 100 B.P.
GaK-623: square IX, level 11	3800 ± 110 B.P.

GaK-622 dates wood carbon from the lower part of the ash lenses, at 50 cm. below surface. GaK-623 comes from lumps of carbon found in the lowest level of the black silt. Its depth was 122 cm. below surface.

Professor Kigoshi points out³ that the calculations are based on a half-life of 5570 years, and on modern carbon activity given by 95 per cent of NBS standard oxalic acid. The errors quoted are statistical only.

¹ This point was drawn to my attention by Mr J.N. Jennings.

² G.H. Dury, 'Australian Geochronology: Checklist 2', Australian Journal of Science, 29, 1966, p.162.

³ Gakushuin University, in litt., 5/7/1965.

Division of the material

The two divisions in the visible stratigraphy of the excavation - the ash lenses and the lower black silt - can be seen over most of the main 4 x 3 m. excavation, but are not visible on the south side near the bedrock or in the three square metre extension. The same division, obscured in the same places, can be observed in the distribution of some artefacts, especially flaked stone implements. Fig. 6.10 demonstrates this using the three-dimensionally recorded stone implements only.

Table 6.2 shows the distribution of all flaked implements by square metres and spits and Table 6.3 the distribution of waste stone (see pp.199-200). Although the numbers are small there are clearly two concentrations of material in Squares I-IX, separated by level 5. This is confirmed by the presence of marine shell and pottery down to level 4 only. The faunal material, however, does not group in this way but is concentrated in levels 3 and 4, with the amount declining rapidly below this.

Squares X-XV, at the south end of the site, show a unimodal distribution of all artefactual material. In an attempt to see whether a division could be made to parallel that already seen in the other part of the site five attributes of the flaked implements were examined by levels. Use-wear type and retouch type and angle suggested that the upper horizon should contain levels 1-3, while weight of implements and whether they were made on a flake or a core-lump suggested levels 1-4 should be included in Horizon I. The number of edges per implement did not vary. It was also noted that marine shell occurs in level 4 in this part of the site.

It seems likely that in squares X-XV the bimodal distribution of the material has been obscured by human activity and the nearness of bedrock. However, the site must be divided into horizons for the purpose of analysing the flaked stone: three horizons have therefore been created, based on inspection of the material and the attribute tests above. These horizons are:

Horizon	Square	Level
I	I-IX	1-4
	X-XV	1-3
II	I-IX	5-7
	X-XV	4-5
III	I-IX	8-11
	X-XV	6-8

For other analyses, where finer divisions are necessary, the excavated levels have been treated as equivalent over the whole site. This may distort the final picture slightly, but it allows a finer separation of material.

The volumes of material in each level are:

Level	Volume (cu. metre)	Level	Volume (cu. metre)
1	1.6	7	1.0
2	1.5	8	1.0
3	1.9	9	0.5
4	2.1	10	0.8
5	1.7	11	1.0
6	0.8		
Total			13.4

Table 6.5.2. - Impersonal Relationships¹

Level	Square											Total	Number/cent meters				
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI			XII	XIII	XIV	XV
1	1	1	-	1	1	1	1	1	-	-	-	-	-	-	-	6	3.6
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	13	13.2
3	2	4	11	2	2	2	2	2	1	7	3	3	3	7	3	36	29.2
4	-	1	1	1	2	1	1	1	1	10	11	11	-	2	3	38	31.2
5	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	11	9.0
6	1	-	2	-	1	1	27	9	6	7	12	20	-	-	4	90	112.5
7	2	3	4	5	6	4	3	6	29	-	-	-	-	-	-	54	51.0
8	-	1	3	4	2	4	2	6	12	-	-	-	-	-	-	33	21.0
9	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	11	9.0
10	-	2	-	-	2	1	-	1	3	-	-	-	-	-	-	13	16.2
11	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	4	2.0
Total	6	12	23	18	20	23	29	27	24	26	32	47	6	18	18	418	311.9

¹ Excluding ones plot.

Table E.3. Water Items - Distribution^a

Level	Spores											Total			
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		XII	XIII	XIV
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	7	2	10	6	4	6	6	15	7	2	6	11	6
4	4	4	2	2	3	1	4	1	4	4	2	2	2	2	2
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Total	8	10	11	12	29	18	48	34	39	39	37	45	47	11	31

^aTypes per material analyzed: total 31 strains, 6 from III and 25 from IIII.

2. Fauna and Flora

1) Domestic Fauna¹

Pig (Sus scrofa Linnaeus) only occurred within some 30 cm. of the surface. Eight definite and three probable pig bones and teeth were found, comprising at least one adult and one juvenile. The following bones were identified: one each of scapula, calcaneum, distal tibia, distal humerus, ? tibia and ? rib. The five teeth were: 2 pre-molars, 1 PM³, 1 DM₃, 1 ? molar. Six of the bones occurred within the top level, three in level 2 and the final two (including one questionable bone) in level 3. It cannot be determined whether the animals were domestic or feral. All bones lie well above the level of GaK-622 (770 ± 110 B.P.).

Dog (Canis familiaris) is recorded from the top level only, where one PM₃ was found.

The virtual absence of dog is quite remarkable as one would expect it to be common in a site to which a large number of hunted animals was brought.

The rarity of pig is less surprising if one considers that they are eaten today only on ceremonial and special occasions and would be rare in a refuge or occasionally-occupied site.

¹
All identifications were checked by Mr C.L. Cram, ex-Department of Anthropology, A.N.U., 28/11/65.

2) Wild Animals

A wide range of animals was found. The identifiable post-cranial bones have been counted and the non-identifiable bone has been weighed, but other analyses follow the procedures described in Ch. 3.

Over the whole of the site the fauna was concentrated in the upper horizon, as defined by the stone artefacts.¹ If the fauna were analysed only in terms of the three horizons several important facts would be obscured through lack of a sufficient number of units. All analysis is therefore based on excavated levels treated as equivalent over the whole site.

The following animals have been identified:

Macropodidae	: <u>Thylogale bruijni</u> (Schreber)	Wallaby
	: <u>Dorcopsulus sp.</u>	Wallaby
	: <u>Dendrolagus sp.</u>	Tree Kangaroo
Phalangeridae	: <u>Phalanger ?spp.</u>	Cuscus
	: <u>Dactylopsila spp.</u> or <u>Dactylonax sp.</u>	Striped phalanger
	: <u>Petaurus breviceps</u> (Waterhouse)	Flying phalanger
	: <u>Eudromicia spp.</u>	'Dormouse' phalanger
	sub-genus <u>Pseudocheirops spp.</u>	Large ring-tailed phalanger
	sub-genus <u>Pseudocheirus spp.</u>	Small ring-tailed phalanger
Peramelidae	: <u>Peroryctes sp.</u> or <u>Echymipera sp.</u>	Bandicoot

¹

Calculated as a minimum number within each horizon, only 79 animals occur in Horizon III.

Dasyuridae	: <u>Satanellus</u> <u>albopunctatus</u> (Schlegel)	Native 'cat'.
	: <u>Antechinus</u> sp.	Broad-footed marsupial 'mouse'.
Megachiroptera:	<u>Pteropus</u> sp. or <u>Dobsonia</u> sp.	Flying-fox.
Muridae	: <u>Hyomys</u> <u>goliath</u> (Milne-Edwards)	Giant rat.
	: <u>Mallomys</u> <u>rothschildi</u> Thomas	Large rat.
	: <u>Anisomys</u> <u>imitator</u> Thomas	
	: <u>Uromys</u> sp.	Giant naked-tailed rat.
	sub-genus <u>Pogonomys</u> 3 spp. (A,B,C)	Prehensile-tailed rat.
	sub-genus <u>Rattus</u> 3 spp. (A,B,C)	Black rat.
	: <u>Melomys</u> or <u>Pogonomelomys</u> 3 spp. (A,B,C)	Naked-tailed rat.

The 287 rodent mandibles from this site were identified by Mr J.A. Mahoney.¹ He divides the small murids into three or four genera and nine species and gives the following data for the length of the lower three molars in each:

¹

Department of Geology, University of Sydney. These now form part of a valuable reference collection.

Genus	Species	Length M_{1-3} (mm.)
Pogonomys	A	5.0
	B	6.1
	C	6.8
Rattus	A	6.5
	B	ca. 5.2
	C	ca. 4.8
Melomys or Pogonomelomys	A	6.0
	B	5.9
	C	8.0 (M^{1-3} only)

His reference system is retained in the following analysis.

From the mandibles¹ it is calculated that the site, treated as a whole, contains 454 animals, in the form of:

152 small rodents
115 macropods
96 phalangers
91 other animals

The minimum number rises to 502 (including 166 small rodents) if the calculation is based on the mandibles within each excavated level over the whole site.

Of the 502 animals, 360 are identifiable to generic level and the rest may be given at least family status. This may be seen in Table 6.5, which sets out the minimum number of animals in each spit. Table 6.4 summarises this data in terms of the percentage of each level which each major animal group forms.

¹ Except for Pseudocheirus spp. whose preserved maxillae outnumber its preserved mandibles.

Table 6.4 : Animals per level (per cent)

Level	Macropods	Cuscus ¹	Small Rodents	Other	Total Number
1	2.7	-	91.9	5.4	37
2	28.6	3.6	51.7	16.1	56
3	33.0	20.3	35.2	11.5	182
4	23.8	27.0	16.4	32.8	122
5	20.3	33.4	19.2	26.9	78
6-7		40.7			25
8-11	11.1		14.8	33.3	2

¹ Including unidentified phalangers (mostly cuscus?).

Table 6.1. Minimum animals based on spits.¹

Animal	Adult or Juvenile	Levels							Total animals, in whole site.
		1	2	3	4	5	6-7	8-11	
Thygale b.	A	1	5	15	10	5	-	1	37
	J	-	6	19	8	5	1	-	37
Doropodina	A	-	-	3	3	4	1	-	11
	J	-	-	-	1	2	-	-	3
Dendrogaue	A	-	1	1	-	-	-	-	2
	J	-	-	-	-	-	-	-	-
Phalangia	A	-	1	15	17	18	8	-	59
	J	-	-	1	5	2	-	-	6
Pseudoscorpia	A	-	1	-	8	4	3	-	16
	J	-	-	1	-	-	-	-	1
Pseudoscorpia	A	-	1	4	8	4	2	-	19
	J	-	-	3	2	2	-	-	6
Dactylopoda/Dactyloina	-	-	1	5	-	-	-	-	4
Putresca	-	-	1	-	1	2	-	-	4
Eufrosina	2	-	2	2	-	-	-	-	6
Antschina	-	-	1	1	-	-	-	-	2
Stenelmia	-	-	1	-	-	1	-	-	2
Pterocera/Schizopora	-	-	1	5	2	1	1	-	15
Pteropus	-	-	1	-	-	-	-	-	1
Hymen	-	-	1	-	4	2	-	-	7
Hallmaga	-	-	-	-	2	1	-	-	3
Asilaga	-	-	-	-	1	1	-	-	2
Uroga	-	-	1	-	2	1	-	-	4
Pogonomya A	6	5	13	4	2	-	-	-	30
Pogonomya B	-	-	2	-	1	-	-	-	3
Pogonomya C	-	-	1	-	1	-	-	-	2
Sattua A	5	5	8	2	4	1	-	-	23
Sattua B	-	-	2	-	-	-	-	-	2
Sattua C	1	-	-	-	-	-	-	-	1
Meloe or Pogonomya A	12	9	14	3	3	1	-	-	42
Meloe or Pogonomya B	1	-	4	-	-	-	-	-	5
Meloe or Pogonomya C	-	-	3	1	-	-	-	-	4
Unidentified meopoda	-	4	22	7	2	-	-	-	35
Unidentified phalangia (mostly ranae)	-	1	21	13	4	2	1	-	44
Unidentified rodena	9	12	17	10	4	2	-	-	56
Unidentified others	-	3	2	-	4	-	-	-	9
Totals:									
macropoda	1	16	60	29	16	2	1	-	125
cutera	-	2	37	53	26	10	1	-	109
small rodena	24	29	24	20	15	4	-	-	152
other	2	9	21	40	21	9	-	-	102
Total animals	37	56	182	122	78	25	2	302	526

¹ Calculations on a within-spit basis.² Minimum animals calculated on site as a whole.

Several features of this fauna stand out. One is the sheer number of animals present - some 500 are represented by mandibles. This number contrasts strongly with the artefactual situation where human activity left only a fairly small number of tools and a very small amount of waste stone.

Then there is the concentration of animals in and above level 5. There is almost no lower concentration of faunal material to parallel the lower horizon of artefacts. This may document poor preservation of bone in the lower part of the site although such bone as does occur there is in good condition.

Thirdly, within the upper horizon there is a very noticeable change in the fauna - the steady decline and disappearance of cuscus, the rise in rodent from level 4 to level 1, the rise in macropod at least to level 3 or 2, and the decline in other animals in level 3 and above. These changes occur mostly within the last 1,000 years.

If one assumes that these changes do not simply represent changing hunting patterns then certain inferences may be made:

1. The decline and disappearance of cuscus, which is primarily an arboreal animal,¹ may document an increase in grasslands. The increase in macropods and especially Thylogale probably supports this hypothesis.²

¹ Van Deusen, Appendix 3.1. Compare S. and R. Bulmer, 1964, p.50 - but even if one of the phalangerids is mostly terrestrial it is not a grassland dweller.

² See Appendix 3.1.

2. The absolute dominance of small rodents in level 1 may relate to the small numbers in the sample or to the fact that nowadays hunting is not very important. Around the site today most hunting is done by youths, and large animals are rarely caught.

3. The ecological significance of the small rodents is unclear. Mahoney¹ is inclined to regard Pogonomys as perhaps a tree dweller, but Rattus is clearly non-arboreal. The other genera are not defined sufficiently well for discussion. Since there is no change over time in the relative proportions of the two named genera they do not document any ecological shift.

4. The balance between adult and juvenile animals is generally about normal for a hunting economy. At Aibura with one exception it is four or more adults to one juvenile, comparable with a ratio of 3:1 or more in other parts of the world.² The exception is Thylogale bruijnii with an adult:juvenile ratio of 1:1. This ratio is difficult to explain, but since Thylogale breeds in the grassland this may account in part for the unusually high figure.

5. Table 6.6 sets out the relationship between mandibles and other bone. Small rodents have been excluded because some of these creatures might have been caught in the cave.

¹ Pers. comm.

² J.D.G. Clark, 1954, pp.75, 79-80; E.S. Higgs, 'Fauna' in Rodden, 1962, p.272.

Table 6.6 : Mandibles and other bone

Spit	No. mandibles	No. of identifiable bones	Weight non-identifiable bone (gm.)	Mandible as percentage of total ident. bone (incl. mandible)
1	3	44	57.8	6.4
2	36	111	307.9	24.5
3	150	436	1392.6	25.6
4	145	574	1486.2	20.2
5	79	416	905.1	16.0
6	21	145	305.0	12.7
7	2	35	104.2	{ 9.3
8	2	4	45.1	
9	-	2	5.0	-
Totals	438	1767	4608.9	19.9

The steady rise in the percentage of mandibles is most noticeable. By spits 4-2 it is higher than one would expect for a site to which animals were brought before butchering.¹ And yet it would be unusual in New Guinea (as elsewhere), if animals were butchered away from the site and their heads were included in the part brought back, unless there were specific cultural reasons for doing this. However, it is normal practice in this area today for villagers to keep the mandibles of larger animals caught by hunting hung up in their huts.² If this were the practice in prehistoric times it might explain not only why mandibles are so common but also why they outnumber maxillae to such an extent.

3) Birds

Bird bones initially identified as such, were submitted to Dr J. Yaldwyn for identification of domestic fowl. He reports that one tibia from level 3 is very likely to be fowl (Gallus gallus), while two femurs and a tibia from levels 4, 5 and 6 respectively may be fowl but need detailed checking. This suggests that fowl may be several hundred years old in this part of the Highlands.³

¹ Compare the figures for Batari, given in Ch. 5.

² I bought a number of these 'trophy skulls' (Van Deusen and Keith, 1966, p.723) from Barabuna villagers in 1964. These were mostly cuscus which may record either an expansion of hunting territory following European pacification of the area or special preservation of these skulls (mandibles) by the Tairora or the fact that I was sold only those which were least valued.

³ Compare S. Bulmer (1966), p.26.

The other bird bones all came from level 3 and above. They include the following:

- level 1 - 1 very small pelvis
- level 2 - 2 metatarsals of small perching birds
- level 3 - 2 small femurs
 - 1 metatarsal of a small perching bird
 - 3 fragments of small perching bird
 - 1 medium size humerus
 - 3 unidentifiable.

After the extraction of recognised bird bones Mr R.J. Scarlett¹ inspected all bones recovered from levels 2, 4 and 6 and identified any bird bones present. He reports one distal phalange of probably cassowary in II/(2) and an anterior fragment of sternum, about pigeon size, in VIII/(6). A few other fragments of bird bone have been noted but not identified. It is clear that cassowary and other birds were not commonly brought to Aibura, in contrast to the picture from sites in the Western Highlands.²

Twenty-three fragments of cassowary eggshell were found, weighing 9.3 gm. Nine large fragments (5.2 gm.) were found close together and may come from one eggshell. The other fragments were mostly in the six southern squares and were spread through levels 3 (6 frag.), 4 (4 frag.) and 5 (5 frag.). It is possible, but unlikely, that only one shell is represented.

¹ Osteologist, Canterbury Museum, Christchurch.
Mr Scarlett's expert help is gratefully acknowledged.

² S. Bulmer (1966), pp.94, 118.

4) Reptiles

Four reptile fragments have been identified by Dr Barwick. They are the right maxilla of an Agamid lizard from IV/(8) and three fragments of snake, sub-family Pythoninae, from adjacent squares in levels 4-5. These animals were probably eaten.

5) Human remains

Scattered remains of several, possibly three, individuals were found, but nothing approximating to a burial was noted. The bones have all been described in detail by Dr L. Freedman,¹ whose report appears in Appendix 6.1. The details of the bone associations are also discussed there. It must be noted here however that all individuals appear to have been placed in the cave before some 700 years ago. Two are at or slightly below the level of GaK-622 while the third is well down, in Horizon III. It is unfortunate that so much of this bone is broken or it might have provided some idea of the prehistoric racial groups in this area.

6) Mollusca

Mollusca from three environments - marine, freshwater and land - are found at Aibura. All have been identified by Dr D.F. McMichael.

a) Twenty five pieces of marine shell were found, all in and above level 4. Seven genera are represented, with the Commercial Trochus shell being most common. None of this shell has been altered by human action. McMichael

¹Then of Dept. of Anatomy, University of Sydney.

points out¹ that the presence of the Ringed Money Cowry may be unusual since the more widely used form at the time of European contact was the Money Cowry (Cypraea moneta L.). There is little change in the amount of shell which came to the site at different periods after level 4 (Table 6.7).

b) Two genera of freshwater mussels have been identified, but these number only five of the 41 fragments. Freshwater mussel shells occur down to level 6, are concentrated in levels 3 and 4 and decline above this. It is not known whether this decline reflects local ecological changes. One piece of shell has a small hole drilled through it (see below, Table 6.8).

c) Ten fragments of land snail shell have been recorded, nearly all from level 3. The fragments come from five genera, four of which are of the Camaenid family which form the typical local land snails. It seems likely that most of these snails were naturally incorporated into the deposit. The following genera are represented:

Helicinidae: <u>Helicina</u> sp., near <u>coxeni</u> Brazier.	Level 3, 1 frag.
Camaenidae: <u>Chloritis</u> (<u>Disteustoma</u>) sp., near <u>dinodeomorpha</u> Tapp. Can.	Level 3, 1 frag.
: <u>Chloritis</u> (<u>Disteustoma</u>) sp., near <u>lepidophora</u> Kobelt	Level 3, 3 frag.
: <u>Kendallena</u> <u>broadbenti</u> (Brazier)	Level 3, 1 frag.
: <u>Sulcobasis</u> sp.	Level 3, 1 frag.
: not further identifiable	Level 1, 1 frag.; Level 3, 2 frag.

¹
In litt., 11/2/1965.

Table 6.7 : Marine shell - numbers

Shell	Level				Total
	1	2	3	4	
<u>Trochus niloticus</u> L. (Commercial Trochus)	4	2	2+1?	1+4?	9+5?
<u>Cypraea annulus</u> L. (Ringed Money Cowry)	2	1	1	-	4
<u>Ovula ovum</u> L. (Egg Cowry)	1	-	-	-	1
<u>Nassarius thersites</u> Brugiere (Plicated Dog Whelk)	-	-	1	1	2
<u>Charonia tritonis</u> L. (Trumpet Shell)	-	-	-	1	1
<u>Oliva sp.</u> (Olive shell)	-	-	-	2	2
<u>Cymatium s.l.</u> or <u>Murex s.l.</u>	-	1	-	-	1
Totals	7	4	4+1?	5+4?	20+5?

Table 6.8 : Freshwater mussels - numbers

Shell	Level						Total
	1	2	3	4	5	6	
<u>Velsunio sentaniensis</u> Haas	-	-	-	-	1	-	1
<u>Hyridella (Nesonaia) guppyi</u> <u>alpiana</u> McMichael	1	1	1?	-	1?	-	2+2?
Unidentified	3	4	12	13	3	1	36
Totals	4	5	12+1?	13	4+1?	1	39+2?

7) Vegetable matter

i) Pollen analysis.

Eight soil samples ranging from the base to the top of the site were tested to see whether they contained pollens. Dr J.M. Matthews¹ reports² that all samples were treated with acridin orange 0.1 per cent solution and then examined with a fluorescence microscope. No pollens were observed in any of the samples tested.

ii) Carbon.

Two samples of wood carbon from the lower levels of the site were thin-sectioned and examined by the Division of Forest Products, C.S.I.R.O.³ The sample from level 7 was of Lauraceae, ?Cryptocarya. This is a large furry-leaved tree which grows up to 30 m. in height. It prefers well drained soils and is normally only found in rain forest.⁴ The sample from level 12 was a Graminae, Bambusa sp., a bamboo. Bamboos grow around most village sites and are one of the essential woods in village life.

It would be too much to infer that these two carbon identifications indicate a more wooded environment during earlier occupation of the site, especially since this material has passed through a 'cultural filter'. However,

¹ Then attached to Dept. of Geography, I.A.S., Australian National University.

² In litt. 22/1/1965.

³ By courtesy of Dr H.D. Ingle, Senior Research Officer, 4/11/1964.

⁴ J. Flenley, pers. comm.

it is interesting to consider this evidence in conjunction with the faunal data. Moreover, these identifications suggest that floral information may be obtained from New Guinea sites even where pollen is absent.

3. Artefacts

1) Recent Objects

Two objects from the top 2-3 cm. of the deposit show that the site has been used subsequent to European trade goods entering this area, i.e. ca 1930.¹ These are a yellow bead (diam. 3 mm.) of a type widely used in necklets and armlets and some dark blue trade-store paint used nowadays for both body and artefact decoration.

2) Pottery

Sixteen sherds of pottery and two pieces of shaped ?burnt clay were found. Fourteen sherds were in level 3 and two in level 4, so that all pottery comes from above GaK-622. The two pieces of shaped clay were found in level 2. Sherds were found over the whole excavation but were concentrated towards the southern end.

The pottery had been divided into three groups by Mr J. Specht,² whose descriptions follow:

- (1) Two body sherds of fine thin ware. III/(3) is red (5YR 4/6), grit filled with the grits ranging from sand to 3 mm. stones, 4-5 mm. thick and hand made. XIV/(3) is

¹ Watson, 1964, p.1.

² Dept. of Anthropology, A.N.U. I am grateful to Mr Specht for his assistance.

5YR 5/3, without grit or sand fill, 3.5-4 mm. thick and possibly hand made. The exterior is smooth but without obvious signs of smoothing.

(2) Four body sherds of fine thin blackish-grey ware (XV/(3) (two sherds), XIV/(3) and 22.IX/(3)). These were found in quite close association and possibly all belong to one pot. The fabric is fine with a few small grits which are possibly part of the original clay. These sherds are all 2.5-3.5 mm. thick.

(3) These ten sherds are much more heterogeneous than the other two groups and must be classified simply as coarse hand-made pottery. Three sherds come from rims, one or possibly three from shoulders and the remainder are body sherds.

VIII/(3). The 'incurved' rim of an open-mouthed bowl, made of red-brown sandy fabric. The rim has an applied band on the outside, or perhaps a flap of clay has been pulled up from the rim and folded over. The base of this band is abrupt and overhanging the rest of the rim.

XII/(3) (Fig. 6.13f). A rim sherd of grey-brown sandy fabric with the rim clearly made by the same technique as VIII/(3). A coarse black deposit adheres to the inside of this rim.

X/(4) (Fig. 6.13g). Rim sherd of a wide mouthed open bowl made in fine clay with a sand and up to 1.5 mm. grits filler. The rim is everted and part of it lay horizontal. The interior is grey and the exterior red-brown. On the horizontal part are two nearly parallel wavy lines while three vertical nail impressions occur on the actual rim.

239.XIII/(3)¹ is an ornamented shoulder sherd of a large open-mouthed pot. The fabric is sandy, the colour red-brown on interior and core with a black exterior. The body is marked on the outside with a line of angled impressions made probably with a piece of wood. Above this is a wavy relief band. Both these stand out about 5 mm. from the neck, which is decorated with incised cross-hatching.

60.III/(3)i is a reddish body sherd, 2.5YR 5/6, 6-7 mm. thick, of a medium fabric with grits up to 3 mm.

60.III/(3)ii. Medium ware sherd with small grits filler. Orange-brown core and grey-brown exterior. The sherd thickens slightly towards a rim or shoulder, and the thickness is 7.5-10.5 mm.

VI/(3). A soft, medium to coarse fabric with grits of quartz etc. up to 1.5 mm. Orange-brown exterior with grey-brown core. Now 6 mm. thick but the outside is apparently rather weathered.

22.IX/(3). A fine fabric with fine sand filler and smooth surfaces. Colour grey-white. This sherd is 7-8 mm. thick.

VIII/(3). A medium fabric with sand up to 2.5 mm. long as a filler. Black on one side (? exterior), red-brown on the other side, this sherd thickens from 4.5 to 9 mm.

VII/(4). A brown-grey sherd with red-brown surfaces thickening slightly toward a lip or at a shoulder. The filler is very gritty with small stones up to 6 mm. The

¹ Number before stop refers to the catalogue number.

interior surface has been smoothed horizontally and the sherd is 6-8 mm. thick.

(4) IX/(2). The two fragments of ?burned clay are red (2.5YR 6/6) and concave-convex in section as though pressed against a curved object. On the inside of one is a small deep impression which looks a little like a bamboo node. These fragments are probably just slightly burnt clay without additives and may be some kind of daub or due even to chance.

This pottery is almost certainly foreign to the area as there are no records of pottery making nor are sherds commonly found there. The only recorded pottery making in the Highlands is among a few Agarabi villages bordering on the Ramu Fall.¹ Watson reports that: two forms are made, 1) a high-necked jar with slightly everted rim and pointed base, decorated on the lower part of the neck and the flat lip; 2) a small globular form with short everted rim and flat lip. Decoration is on the rim and shoulder. All decoration is on the exterior of the pots. Motifs include incised parallel wavy lines, parallel horizontal lines and straight rows of punctate dots. Incising is done with stocks. The average thickness of ten measured sherds was five-eighths inch (16 mm.). Pots are made by coiling and smoothing. A local clay containing some sand and angular particles is used, but no filler is added purposefully. Colours range from tan to grey-black, often distributed over the same pot.

¹
V. Watson, 'Pottery in the Eastern Highlands of New Guinea', Southwestern Journal of Anthropology, 11, 1955, pp.121-8.

From Watson's description it seems likely that some of the Aibura sherds are of this type of pottery, for example the rim sherds in group 3. Agarabi people say that their pots are traded to the Tairora and some have been seen there.¹

Rim sherd 239.XIII/(3) is decorated in a style unlike any Agarabi pottery but similar to that made in the middle and upper Markham. The normal Markham pot is a globular bowl with everted rim and marked shoulder and decorated on neck, shoulder and rim.² Pottery said to come from the Markham is used today in Barabuna and other Tairora villages. I collected some of these pots at Barabuna: the mean thickness of 15 sherds is 10.2 mm., with a range of 7-13 mm. This pottery is as thick as most sherds of group 3 (above), but is thicker than sherds 1 a 2.

A petrological examination of six sherds has been made by Mr C.A. Key (Appendix 6.2). The sherds fall into three groups of which the largest (4 sherds) contains similar raw material to Agarabi type pottery although the latter is much thicker and less well fired. All 4 sherds are from Specht's group 3. Another sherd (XIV/(3)i), Specht (1) apparently contains marine shell fragments and was made on the coast. The last sherd (239.XIII/(3)) contains raw material unlike either the Agarabi or the Markham sherd available for comparison. I think, however,

¹ Watson, 1955, p.126. See also D.S. Grove, Kainantu Patrol Report KI, 14 August 1947, pp.9-10.

² K. Holzknrecht, 'Über Töpferei und Trontrommeln der Azera in Ost-Neuguinea', Zeitschrift für Ethnologie, 82, 1957, plate 36.

it may well have been made somewhere in the Markham; it is clearly different from any Highlands pottery. It must be remembered that this is only Mr Key's first small study and there are extremely few comparative specimens available, while some problems of identification remain to be solved. However, this work clearly has considerable potential for defining prehistoric trade.

Mr Key's examination suggests that pottery came into Aibura not only from other Highlands communities, but also from the coast 80 miles away. The over-land transport of such bulky and fragile artefacts is unexpected and throws a new light on the dimensions of trade over the last 1,000 years or so. The presence of so many different pots, which were probably always valuable objects,¹ also suggests that Aibura was not simply a casual stopping place but one to which people brought a variety of possessions.

3) Axe-adzes

One whole axe-adze, three cutting edge and body fragments, two butts and three fragments were found in the excavation from levels 2 to 6. One ?axe-adze was found in level 7.

All except one fragment are made in low grade metamorphic rocks such as hornfels.² These rocks are very common in the area and it would be difficult to locate a

¹ Watson, 1955, p.126.

² Identifications by Mr J. Chappell, Department of Geography, S.G.S., A.N.U.

particular source for the axes. One fragment (112.XI/(4)) is made of slaty-schist. All are wholly or partly ground.

(1) Whole axe-adzes.

254.XV/(6) (Fig. 6.13b). This whole axe is small with a planilateral cross-section. Length 6.0 cm., max. width 3.1 cm. at 2 cm. from the cutting edge, thickness 0.8 cm. One side tapers slightly towards the butt, but the other bends sharply at about the mid-point of the axe. The butt is thus 1.2 cm. wide, squared, and set off-centre. The cutting edge has been formed by alternate bevelling so that the edge, viewed end-on has a marked twist about the centre-point. In plan, the cutting edge is only slightly convex. The axe-adze is wholly ground.

(2) Cutting edge and body fragments.

24.I/(3). A lenticular sectioned fragment, length 5.6 cm., width 4.7 cm., max. thickness 1.0 cm. The bevel has been well ground, but the faces and sides are only partly ground. The cutting edge is markedly curved in plan, and runs smoothly into the sides. The implement is bevelled asymmetrically with the cutting edge being slightly hollow ground.

249.XV/(3) (Fig. 6.13a). The cutting edge and part of the body of an axe of planilateral cross-section. This implement seems to have been wholly ground on both faces, but a large part of the grinding on each side has been subsequently flaked away, so that one face is now quite curved. The widest part preserved is across the cutting edge, which forms a slightly convex curve. The junctions between the cutting edge and the sides are sharp.

The edge is beveled slightly asymmetrically but is straight when viewed end-on. Length 6.6 cm., width 5.4 cm., thickness 1.6 cm.

83.VII/(4). A lenticular sectioned body piece with slightly flattened sides and fairly flat faces. Length 7.0 cm., width 4.8 cm., thickness 1.1 cm. The cutting edge is convex but is not symmetrical about the centre line of the implement. The bevel is marked and asymmetrical but the cutting edge is straight when viewed end-on. The widest part of the implement is at the cutting edge.

(3) Butt fragments.

XV/(3). A flaked butt, only very slightly ground on one side. Flaking seems to have removed some grinding. The poll is squared off in plan (2 cm. wide). The sides are clearly diverging so that the width must have been greater than 4.4 cm. Lenticular cross-section. Maximum thickness is 1.25 cm.

72.XI/(4). The pointed butt of a lenticular sectioned partly ground piece. The sides are ground to a V-section with 2 bevels, so that the axe has six ground planes. The sides are diverging. The thickness must have been greater than 1.4 cm.

(4) Fragments.

XV/(2). Chip showing grinding on one face and part of a curved side.

112.XI/(4). Flat, thin (0.8 cm.) piece of polished slaty-schist, ground on both faces with a sharp edge along one side. If this edge is the side of an axe then it must have been more than 5.5 cm. wide.

XV/(4). Small chip of hornfels showing grinding on one face and one side.

(5) ?Axe-adze.

217.IV/(7) (Fig. 6.14a). An elliptically shaped, ground blade, length 14 cm., width 4.7 cm., thickness 0.8 cm. In cross section it is lenticular with double bevelling on both sides. The faces are flat. It is ground all over, there are no signs of flaking and all edges on this implement are sharp. The cutting edge is convex in plan, straight, and formed by symmetrical bevelling. When looked at side on each side shows a slight S-twist, so that the whole artefact has a slight propellor shape. There are traces of abrasion at the mid-point of one side. The butt-end half of the implement is covered with small black lumps of ? mastic or gum-like material,¹ and traces of this occur along one side (opposite the abrasion) down to the cutting edge. No traces of wear are visible under a 10x lens.

This implement is possibly made in a thermally altered tuff (e.g. rhyolite) which may have undergone some changes while in the soil. Chappell points out that there is an outcrop of rhyolite six miles north of Kainantu.²

Although it is very similar in form to some New Guinea axes, the fine sharp edges and the occurrence of ? gum suggest that this implement may not have been used for

¹

This has been tested over a flame, but gave no reaction. Under a lens it looks like gum.

²

See McMillan and Malone, 1960, Map 1.

chopping or, if it was, it was not hafted in the normal way. The occurrence of gum on the butt and all down one side (even if only one one face) tend to suggest a knife-like tool rather than a chopper. The depth at which the implement was found precludes European influence in its construction. There seems to be no records of gum-hafted stone tools in the Highlands, although a light smear of gum is used in making some wooden artefacts (e.g. arrows).¹

(6) Summary.

There are of course too few axes at this site to allow comparisons with other collections from either this area² or the Highlands as a whole. It is nevertheless worth noting that planilateral cross-sections are found on two of the seven axes where this can be observed. However, these implements appear to be much less square than the Western Highlands planilateral axes, though this awaits a metrical definition. The different cross-sections do not seem to be vertically separated in the deposit.

¹ See Chapter 4.

² For example R.M. Berndt's collection briefly and badly described by Adam, 1953, and referred to by S. Bulmer, 1964a, pp.253-5. This collection is no longer in the Dept. of Anthropology, University of Sydney, and cannot at present be found.

Table 6.9 : Axe-adzes

Level	Number of Pieces				Total
	Whole	Cutting edge	Butt	Fragment	
1	-	-	-	-	-
2	-	-	-	1	1
3	-	2	1	-	3
4	-	1	1	2	4
5	-	-	-	-	-
6	1	-	-	-	1
7	1?	-	-	-	1?

4) Small Stone Artefacts

Nine miscellaneous stone artefacts deserve separate description as they relate both to the technology practised at Aibura and to certain present-day ethnographic observations.

a) Three fragments of stone annuli. Two of these (82.VII/(4) (Fig. 6.13c); 246.XIV/(3) (Fig. 6.13d)) are made of marble. These have external radii of 72 mm. and internal radii of ca. 40 and ca. 61 mm. respectively. The inner hole is pecked or pecked-and-ground from both faces,¹ while the outer edge is semi-sharp. The thickest part of the artefact is towards the inside hole (max. thickness 14 and 13 mm. respectively). The third piece is a small flat flake of ground shale with part of a ground circle visible on the inner edge (XII/(2)). The radius of this circle is

¹ Compare Blackwood, 1950.

ca. 22 mm. One face of this flake is ground flat for a width of ca. 20 mm. and the grinding then cuts away suggesting an outer circle.

I have suggested elsewhere that these may be clubheads.¹ However the size of the inner hole in all cases is much larger than that of any modern clubhead I have seen, for these have radii of only about 10-20 mm. If they were clubheads they would perhaps be rather more fragile than is compatible with efficiency, even if the shaft were heavily padded. S. and R. Bulmer² record a group of 'small perforated stones' made in a wide range of materials and too small to be clubheads. The latter is not true of these examples, but otherwise these tend to fall into this category.

b) Two fragments (68.VIII/(4); 4.IX/(1), Fig. 6.13e) of stone - one of marble and one of calcite - illustrate that stones were shaped by grooving and snapping. The piece of calcite (4.IX/(1)) is 37.5 x 19.5 x 8.5 mm. and has been ground on both faces. Down the middle of each face and over one end is a deep V-shaped rubbed groove, 2 mm. deep. Traces of similar grooves occur along both faces at one side, which has been formed by snapping. The marble piece (68.VIII/(4)), 35 x 14 x 10 mm. is a squared-section cone-shaped fragment. It is rubbed longitudinally along $3\frac{1}{2}$ sides and snapped off between two pieces of rubbing.

¹ White, 1965a, p.45.

² S. and R. Bulmer, 1964, p.69.

c) VII/(3) is an irregularly shaped, smoothed piece of tuff, 28 x 27 x 16.5 mm. It is clearly a broken fragment of a larger piece. It has many similarities to axe whetstones excavated by R.J. Lampert near Mt Hagen.¹

d) 28.XII/(3) is a large triangular sectioned, long flake of hornfels, 133 x 44.5 x 19 mm. One side is ground, the other side and the base are flake surfaces. The edge between the ground side and the base has small chips removed, apparently through use. The ground side is extremely flat in both directions, which, combined with its size, suggests that if it was part of an axe, this was very large indeed.

e) A small irregular puck of pumiceous rhyolite, 77.5 x 55.0 x 15.5 mm. (VIII/(10)). On one side is a 9 mm. diam. hole some 6 mm. deep set at an angle of about 30°. The other side shows some traces of unidirectional rubbing. This stone is soft but is quite suitable for rubbing stones or bones smooth.

f) A double ended cylindrical point made of calcite (64.XV/(2), Fig. 6.12f). Length 60 mm., max. diam. 7 mm. This artefact may be compared to the calcite cylinders found at Batari. Like them, it is probably a septum decoration.

5) Bone and shell artefacts

There are 15 bone, 2 shell and 2 tooth artefacts. These form a heterogeneous collection, with only two pairs

¹ Now in the Dept. of Anthropology collection. See S. and R. Bulmer, 1964, p.55.

of artefacts being similar. Accordingly all are described separately. They give an interesting picture of the technology employed at Aibura.

The nineteen artefacts are concentrated in the upper levels and are scattered over the excavated area.

Table 6.10 : Bone and Shell Artefacts

Level	Bone	Shell	Tooth	Total
1	1	-	1	2
2	3	-	1	4
3	8	1	-	9
4	1	1	-	2
5	1	-	-	1
6	-	-	-	-
7	1	-	-	1

There appear to be two main groups of objects - decorative and functional - represented. The former includes beads and other objects for threading as well as potential septum piercers etc. The latter includes a spatula, needles, awls and very hypothetically, arrow barbs.

a) Probably functional.

230.XIV/(1) (Fig. 6.12n); 129.XII/(5) (Fig. 6.12l). These two bone points are made of straight lengths of long-bone shaft. Both are ground asymmetrically at the point so that the point is off-centre to the shaft. In each case the non-pointed end is snapped. The diameter of the former is 2.5 x 2 mm. and that of the latter 3.5 x 2.5 mm. respectively. They are similar to Batari points class 2.

XII/(2) (Fig. 6.12k); X/(3). Needles. The first is an unground, slightly curved fragment of bat long bone with a small (diam 1 mm.) hole cut into the medullary cavity. The technique used to make the hole was to cut across the bone with a sharp thin blade and then cut down from either side to the original cut. Traces of the original cut may still be seen on either side of the hole. The same technique used on a similar bone may be seen on a bone needle collected from Legaiyu village, southern Asaro valley, in 1965. The thread is taken through the hole and out of the end of the needle. The point is clearly snapped off. The diameter of this specimen is 1.8 mm. and its length 42 mm. The Legaiyu specimen is 73 mm. long, with approximately the same diameter and a fine asymmetrical point at the end opposite the hole.

X/(3) (Fig. 6.12m) is a highly polished fragment of long bone about the same diameter as the needle. Both ends are snapped off.

XI/(2) (Fig. 6.12i) is a metapodial worked to a very fine sharp point at one end but with the proximal end unfused and unworked. Length 42 mm., width at proximal end 7.5 mm.

42.VI/(3) (Fig. 6.12e). A bone bipoint made from a sliver of longbone shaft. Length 92 mm. One point is slightly broad and flat and is symmetrical with the tool's axis; the other is made on one side of the medullary cavity and is therefore more rounded. The midsection is flattish (7.5 x 4mm.). The black remains of what seems to be a band of gum covers about 17 mm. around the centre of the tool. The gum band suggests that this point may not be a septum decoration but was possibly an arrow or spear point and barb.

XIV/(3) is a small shaft of polished long bone tapering towards one end. Both ends are clearly broken. It may be a part of a bone point similar to 230.XIV/(1) and 129.XII/(5).

5.X/(2). A broken spatula in ? cassowary long bone, 118 x 18 x 5 mm. Both faces are ground at one end to form the spatulate tip which is, however, broken. The other end is also snapped and both ends are chewed, not by rodents. Spatulae are found in the Highlands now but their use is unknown.¹

40.IV/(3). A shaft of bird bone ground down at the tip until it is nearly flat. The actual tip is broken off. The other end has been broken off just before the epiphysis but this may not be accidental. The tip has been ground diagonally rather than around or along the bone. Length 83 mm.

II/(3) is a small sliver of longbone shaft with one corner ground and polished. The grinding marks run the same way right across the edge.

b) Probably decorative.

XII/(3) (Fig. 6.12g). Proximal end and part of a shaft of a ?macropod metapodial, unworked except for a small (2.5 mm.) hole just below the epiphysis. The hole is nearly square, but the bone is both lightly concreted and slightly chewed so that the technique of making the hole has been obscured.

¹
S. and R. Bulmer, 1964, p.55.

XIV/(3) (Fig. 6.12h). A tubular fragment, probably shaft, of bird long bone (diam 6.5 mm.) with a deep V-sectioned groove about half-way along its 28.5 mm. length.

V/(7) (Fig. 6.12j). A bent rib of lenticular cross-section with a small hole bored near one end. The hole has been bored with a rotary motion from both faces of the rib and is less than 1 mm. in diameter. On one face above the hole scratches running across the face can be seen, presumably placed there to aid snapping. The other end is neatly broken at right angles to the main axis of the artefact. 43 x 5.5 x 1.5 mm. This is most likely to be a pendant.

XV/(1) (Fig. 6.12d). A cuscus incisor with a hole (diam. 2.2 mm.) drilled through from mesial to distal surface. Drilling has probably occurred from both faces but this is not clear. This is almost certainly a neck ornament.

235.XV/(2). A boar's tusk, broken laterally as well as at both ends. The external radius is at least 50 cm. Although unworked, this is included because of the widespread use of unworked tusks as nose ornaments in this area.

87.XII/(4) (Fig. 6.12a). A biconcave wheel-shaped bead made possibly from shark vertebra. Diameter 19.5 mm., thickness 7.2 mm., diam. of central hole 6.8 mm. The corners are highly polished and the whole bead gives the appearance of having seen much use.

19.XII/(3) (Fig. 6.12c) is a flat sectioned, oval shell bead 12 x 9 mm. with a 1.5 mm. central hole drilled

from both sides. The thickness of the shell is at least 2.5 mm. so it is probably a piece of marine shell.

76.IV/(4) (Fig. 6.12b). An irregularly shaped nacreous piece of freshwater mussel shell, approx. 14 x 11 mm. with a 1 mm. diameter hole drilled from both sides through it near one edge. This piece of shell was clearly used for decoration.

XV/(3) is a cuscus mandible with a round hole pierced in the ascending ramus. Similar holes are pierced in cuscus mandibles today to hang them up in the houses. This specimen may document the same practice in prehistoric times.

6) Colouring

At least seven different colouring materials were found. Most seem to be iron oxides in orange, pink, red, red-brown and yellow-brown, but there is also a creamy white which is possibly a clay or shale.

The total weight of colouring material is 333.4 gm., split into 37 pieces. Four pieces - one each of pink, white, orange and red-brown - show signs of rubbing. The white piece has a deep tapering groove for 15 mm. along one side.

Colouring material is found throughout the site, from levels 1 to 10.

Level	Number	Weight (gm.)
1	1	0.2
2	3	5.6
3	15	186.1
4	4	9.9
5	3	21.9
6	1	2.9
7	7	58.2
8	-	-
9	1	13.1
10	2	35.5
Total	37	333.4

Seven colours have been distinguished, the commonest being orange, creamy white and dark red, viz:

Dark red, soft	9	37.2 gm.
Pink, more granular	3	65.5
Creamy white, hard	15	76.0
Pinky-brown, soft	2	9.1
Dark orange	4	116.5
Red-brown, hard	1	5.2
Yellow-brown, hard	3	23.9
	<hr/>	<hr/>
	37	333.4

In the context of the cave only the white colouring material was recognised as paint by local people. It was found in levels 3 and 7, mostly in level 3. From the paintings still visible on the walls it is clear that the other colours were probably used as body paint or on art mobilier. The sources of this material are not known.

4. Flaked stone artefacts

1) Waste Material

Only 587¹ flakes and lumps of stone without traces of secondary retouch or use were recovered. This is only 1.37 flakes for every one flaked implement and shows clearly that the site was not a workshop (see Ch. 3). The waste material is spread through the site in a very similar way to the flaked implements, with perhaps a slightly greater concentration in the southwest corner.

A size and weight analysis of the waste material (Tables 6.11, 6.12) shows that there is a virtual absence of very small flakes suggesting that normal kinds of stone knapping only rarely occurred at the site.² These flakes may even suggest that knapping did not occur there since nearly all the 'waste flakes' are large enough to have been used as tools, even though they show no signs of this.

There does not appear to be any significant change in this material throughout the occupation of the site.

¹ Including material from the test pit.

² The absence of small flakes was noted in the material from the test excavation, but I did not realise then that the site was not a workshop. See White, 1965b, p.335.

Table 6.11 : Waste Material - Size¹(a) Squares I-IX

Level	>2"	2-1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ -1"	1- $\frac{1}{2}$ "	< $\frac{1}{2}$ "	Total
1	-	-	1	3	1	5
2	-	1	1	8	1	11
3	-	-	10	26	4	40
4	1	-	5	9	2	17
5	1	1	5	5	2	14
6	4	4	20	20	1	49
7	3	14	19	13	-	49
8	-	4	11	11	1	27
9	2	5	4	10	1	22
10	2	7	8	2	1	20
11	1	3	3	-	-	7
Total	14	39	87	107	14	261

(b) Squares X-XV

Level	>2"	2-1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ -1"	1- $\frac{1}{2}$ "	< $\frac{1}{2}$ "	Total
1	1	-	-	2	1	4
2	1	3	6	13	1	24
3	-	1	14	27	4	46
4	2	5	22	70	5	104
5	2	3	22	41	3	71
6	1	4	15	14	2	36
7	-	1	1	4	-	6
8	-	-	2	1	-	3
Total	7	17	82	172	16	294

¹ Excluding test pit material.

Table 6.12. i. Water Stone - weight, in -

Level	Square															Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	
1		2.6	0.8	2.5	1.7			5.2	11.4				2.2	70.2	1.3	98.1
2	4.3			2.8	2.4	2.4	25.0	3.4			104.7	36.5	4.5	40.6	16.5	260.7
3	6.1	22.9	19.4	8.0	32.9	14.7	24.1		12.3	71.5	27.1	34.1	12.6	62.2	14.7	379.6
4		3.5		19.5	9.0	11.2	13.2	47.6	2.9	276.4	118.5	12.0		12.5	11.9	558.2
5	7.6		23.4	0.6	0.4	19.3	8.0	20.9	67.2	120.5	79.1		31.0	41.5		925.9
6	19.6			19.8			224.2	227.3	87.5	56.5	87.9	208.3		9.6	13.4	699.8
7		2.2	2.5	26.5	63.5	28.9	224.6	128.3	120.0		80.3					192.0
8		13.0		15.5	20.3	18.1		46.3	43.7			16.9				277.1
9		166.2			9.3		114.6	73.7			13.3					283.8
10			48.4			38.0		127.0	148.4							383.8
11								20.9	120.4							151.3
Total	37.6	210.4	63.1	113.4	159.9	133.7	675.2	756.0	380.5	471.4	582.1	386.9	19.3	298.2	99.3	4569.0

Table 6.13. i. Trimming Blocks

Level	Square															Total		
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV			
1				1												1	2	
2																	1	1
3	1		1							2	1	1					1	7
4		2		1			3	2	2	10	6	1	1				1	22
5							4	2	2	7	5	2		2			1	12
6				1			2	2	2	1	3	1					1	11
7		1					1	2	1				1					6
8					2			2	1									5
9					2	1		1	1									1
10						1												1
11						1				1								1
12																		
Total	1	2	1	3	4	4	8	6	10	20	15	6	1	1	3		85	

2) Hammer

One small fragment of river pebble apparently used as a hammerstone was found in IV/(7).

3) Trimming Flakes

Trimming flakes are a constant component of the industry and there is an average of one for every 5 flaked implements. The number of trimming flakes is low, but may be explained by the fact that stone working was apparently very rarely carried out at Aibura (Table 6.13).

By horizons, the numbers of implements per trimming flake are:

I	9.8	(number 10)
II	3.9	(number 56)
III	5.7	(number 19)

This suggests that implements are rarely re-used in the upper horizon. This is consistent with the fact that step-flaked tools, which produce trimming flakes, are less common in Horizon I.

4) Joins

Twenty-five artefacts which had been broken in antiquity were re-joined to make 11 whole pieces. All pairs of fragments except one came from the same square and spit: the odd pair came from adjacent spits and diagonally adjacent squares. Although the numbers are very small, they suggest that there has not been very much movement of material within the excavated deposit.

5) Implements (Figs 6.14b, 6.15)

A total of 444 implements with secondary retouch or use-wear was excavated at Aibura. They seem to be naturally grouped into two horizons over much of the site, but, as has been outlined earlier, have been grouped into three horizons for analysis. The tools have been analysed by both methods described in Chapter 3. They are made in a heterogeneous variety of cherts, often of poor quality.

Most of the tools are scrapers and their morphology does not alter visibly throughout the deposit. They give the impression of being cruder than at other sites, with many implements made on odd shaped chunks and lumps. Many of the tools are made on pebbles, and as such could be called 'pebble tools', but none are outside the general size range of the other scrapers, nor is there any apparent selection of a particular type of stone for them.

The flaking is irregular in position and scrappy in appearance. There is a range of retouch from almost none, especially on some 'side' scrapers, to extensive on 'discoid' scrapers.

Two main changes occur between the horizons. Utilised flakes make up half the total number of tools in Horizon I, but only about a tenth of the total in the lower horizons. It is noticeable that this occurs above the carbon date GaK-622, i.e. within the last 700-900 years.

The other change is that 'multiplane' scrapers seem to become more common in more recent times, although the numbers involved are very small.

Both these changes are similar to those occurring in the top two horizons at Kafiavana; they do not appear at Batari, which, on this evidence, ceased to be effectively occupied at or before 1,000 B.P. The lower levels of Aibura are similar to all levels at Batari.

Table 6.14 sets out the tool types according to the standard typology.

Horizon I. The 'multiplane' tools are heavily flaked, and the 'double concave' scraper is also retouched around the side opposite the projection. Most utilised pieces are small thin flakes, but two are heavy chunks of stone and could be similar to the planes made during the ethnographic study (Ch. 4).

Horizon II. Among the 'side' scrapers there is a wide range of shapes and sizes, including some heavy chunks. There are also four deepish notches. The 'discoïd' scrapers include three with a small unretouched projection at one end. Six of these scrapers are rounded and chunky, while the others are irregular and flatter. The 'double concave' scrapers are unretouched apart from this, except for one which has some retouch on another plane. The 'multiplane' scrapers are very variable in size and shape: a few of the smaller ones seem to have been used as cores. The unretouched cores have only two or three flake scars each.

Horizon III. The 'side' scrapers are mostly lightly retouched and only three have deep notches. The 'double concave' scrapers all have the typical double concavity separated by an unretouched projection. All nine unretouched cores are pebbles with very few flakes removed: the material is poor quality.

Table 6.14 : Tool types - Number

	Horizon		
	I	II	III
1. Total tools	105	229	110
2. Whole retouched tools	15	85	51
3. 2 as % of 1	14.3%	37.2%	46.4%
4. Utilised pieces	50	31	7
5. 4 as % of 1	56.2%	13.5%	6.4%
6. Cores	-	3	9
7. Scrapers - total	15	84	51
- side	3	15	19
- end	-	10	4
- double side	1	5	1
- side and end	1	7	3
- side and double end	-	3	1
- discoid	-	9	4
- double concave	1	3	4
- core	-	1	-
8. - multiplane	9	31	15
9. 8 as % of 7	60%	36.9%	29.4%
10. 'Bifacial' retouch/use	-	1	5
11. Broken retouched tools	31	113	52
12. 11 as % of 1	29.5%	49.6%	47.5%

Attribute analysis

A study of the attributes of all pieces of stone showing retouch or use-wear was made according to the method described in Chapter 3. The analysis is divided into five sections. Particular comparisons with Aibura and Kafiavana sites will be made throughout.

A. Analysis referring to each stone implement as a unit (total 444)

1. Type of stone: Cherts of various kinds provide nearly all of the stone used, especially in Horizon I. The chert used is not of high quality, and suggests that access to good raw material was never easy (Table 1).¹
2. Number of planes/implement: In all horizons about three quarters of all implements were used on one plane only (Table 2). There are about the same number of multiplane implements as at Batari. The slightly higher numbers at both these sites when compared to Kafiavana may reflect similar problems in obtaining raw material.
3. Number of edges/implement: The number of edges per implement shows a slight decrease from Horizon III to Horizon I (Table 3): the change is steady rather than sudden, and is similar to that seen in Kafiavana. In Horizon II and III about 20 per cent of implements have more than four edges which is slightly higher than at Kafiavana and may reflect more re-use of implements.
4. Weight of implements: In Horizon I two-thirds of the tools weigh less than 10 gm.; this very high figure

¹ The tables referred to in this section are given in Volume 2.

is not paralleled elsewhere. In the lower horizons the tools are generally heavier, normally weighing 10-30 gm. The number weighing less than 10 gm. declines very markedly, especially in Horizon III (Table 4). This changing picture is similar to that found in the upper few horizons of Kafiavana. In this attribute, the whole of Batari compares fairly closely with Horizon II at Aibura.

Implements used on two planes seem to weigh rather more than those used on one (Tables 5) and the same is approximately true in relation to edges (Tables 6). While there is no absolute difference, there is a suggestion that larger implements were chosen for re-use.

5. Edges: A total of 1205 altered edges was observed on the implements. By horizons the numbers were:

Horizon	Number	Edges/Implement
I	222	2.1
II	672	2.9
III	311	2.8
Total	1205	2.72

This suggests that implements were not re-used quite so often in Horizon I. The other two horizons are similar to Batari site in this respect and possibly also reflect the raw material situation.

B. The following analyses use the edge as the basic unit of description

1. Whole implements: The number of implements which can be called 'whole' in relation to a particular edge is low, but increases in Horizon I to 16 per cent (Table 7). Only about one quarter of all implements are even 'probably whole', although very few are definitely 'not whole'. The percentage of whole implements is about the same as at Batari and the rise in this percentage in Horizon I is paralleled at Kafiavana, Horizons I-II.

2. Raw material: Only a third - less in Horizon I - of the implements retain some pebble cortex, although other cortex is also quite common. The lower two horizons are similar to Batari in this respect. Horizon I is unlike any other site in that two-thirds of its implements are without cortex (Tables 8).

3. Size and shape of implements:

(i) Weight. The weights of 'whole' and 'probably whole' implements are similar so that the 'probably whole' implements are likely to be in fact whole (Tables 9). There is an obvious decrease in weight from Horizon III to Horizon I with nearly all implements in Horizon I weighing less than 10 gm. Horizon I is unique in this respect. Otherwise implements mostly weigh less than 30 gm., which is similar to the other sites.

(ii) Shape. The Length/Breadth indices of Horizons II-III are similar to other sites; in Horizon I however the index is rather higher and the implements become more 'blade'-like (Tables 10). The upper horizon is also slightly less chunky as expressed by the

Breadth/Thickness index, but the contrast is not marked and differences with other levels and sites are not very apparent (Tables 11).

4. Flakes and cores: The use of flakes is common in Horizon I, but there is a very high percentage of cores and lumps used in Horizon III (Table 12). This suggests that in the lower levels stone was used without much flaking on site, and it may also imply that the raw material was small in size and not much flaked.

C. Descriptive attributes of edges

1. Whole/not whole: Except for Horizon I about half the edges are 'whole' or 'probably whole' (Table 13). The balance between these two groups is very different to Kafiavana although the total is about the same; the picture is more similar to Batari although at Aibura fewer edges are clearly 'not whole'. Horizon I at Aibura is aberrant in having a high number of whole edges.

2. Base type: Table 14 shows that flake surfaces were commonly used for bases and that positive and negative bulbar surfaces were equally used. The increased percentage of 'not applicable' in Horizon I relates to the rise in utilised pieces. The lower number of positive bulb bases compared to Batari or Kafiavana probably relates to the higher number of core-lumps used in the Aibura industry.

3. Preparatory flaking: About half the edges of Horizons II and III are prepared by the removal of one or two large flakes struck from the base (Table 15). These horizons are similar to Batari; Horizon I however shows

the expected high number of 'not applicable' from the utilised edges.

4. Shape of edge: Two-thirds of the 'whole' and 'probably whole' edges in Horizons II and III are concave; in Horizon I nearly two-thirds are straight or convex (Tables 16). This difference is much more marked than at Kafiavana. Both Batari and Kafiavana are generally similar to Horizons II and III.

Table 17 shows that different shapes of edges tend to be about the same length (6-15 mm.) but there are rather more straight edges less than 6 mm. long, especially in the lower horizons. The picture is similar to that found in Batari, whereas at Kafiavana all edges tend to be longer, with very few being less than 5 mm. long.

The Indentation index does not vary through the site (Table 18). There are more concave edges than at Kafiavana suggesting that, as at Batari, the material is more heavily retouched and/or used. There are too few convex edges to make useful statements about them (Table 19).

5. Retouch: Nearly all retouch is step-flaking. Nearly three-quarters of all edges in Horizon I are not retouched, whereas three-quarters of all edges in Horizons II and III are step-flaked (Table 20). The absence of retouch in Horizon I is more marked than in other sites.

Most step-flaked edges are concave, but about 20 per cent are straight (Table 26(b)). Edges without retouch, on the other hand, are frequently straight (Table 26(a)). There is no change between horizons. There appear to be

more straight edges in Aibura than at Kafiavana and possibly Batari, but the difference from the latter is very slight.

6. Use-wear: Just over half the edges in the lower two horizons show use-wear, but over 80 per cent show this in Horizon I. 'Utilised' edges are common in Horizon I. As at Kafiavana the percentage of edges with 'chattering' does not decrease in Horizon I, which suggests that the activity producing this effect continued unabated in more recent times. This points out too that there is no necessary correlation between 'chattering' and step-flaking and that the two must be, in general, the product of different actions performed on the altered edge (Table 22).

About half of all 'chattering' is concave and the other 50 per cent is straight (Table 23(a)). This is similar to the picture found at Kafiavana but differs from Batari, which suggests that differences are not all related to present cultural boundaries.

The shape of 'utilisation' is split roughly in the proportion 2:1:1 between straight, concave and convex (Table 23(b)). This is similar to both Batari and Kafiavana.

The normal length of 'chattering' is under 10 mm. and for 'utilisation' it is 6-20 mm. (Tables 24). About half the 'chattering' at Aibura is 6-10 mm. long and this is similar to the situation at Kafiavana. The high percentage of 'utilisation' whose length is 6-10 mm. is more similar to Batari than Kafiavana.

Where use-wear is concave 'chattering' is more indented than 'utilisation' (Tables 25). There are general

similarities within the horizons of Aibura and with the other sites.

Use-wear is nearly all on acute angled edges. The mode for 'chattering' is $70-89^{\circ}$ in Horizons II and III but $60-70^{\circ}$ in Horizon I. The mode for 'utilisation' is $40-59^{\circ}$ (Tables 27). The picture is similar to that found in other sites.

D. Correlations between attributes

1. Tables 28 and 29 show that there is a high correlation between 'chattering' and step-flaking. Table 28(a) however suggests that this correlation is largely one-way, for while 'chattering' is often found on unretouched edges, use-wear on step-flaking is always 'chattering'. 'Chattering' however is more restricted to step-flaking than at Kafiavana and is similar to Batari in this, though Horizon I at Aibura is aberrant. The proportion of use-wear on tools without retouch (Table 29(c)) is similar to both Batari and Kafiavana.

2. Edges without retouch may be on slightly thinner implements than those with step-flaking, but there is very little difference (Tables 30) except in edges less than 6 mm. long. This may relate to the mechanics of step-flaking.

3. Implements with unretouched edges are slightly less chunky than those with step-flaking (Tables 31). The contrast is not marked however. The unretouched implements are much chunkier than at Kafiavana and this is true, to a lesser extent, of the step-flaked tools.

E. Summary

The most important differences seen in this analysis are between Horizon I on the one hand and Horizons II and III on the other. The standard typology has already brought out some of these differences. These are given fuller expression by the attribute analysis, particularly in respect of the features of utilised flakes, which have gross morphological differences from the other tools. This major change is similar to that seen in the upper horizon of Kafiavana and is expressed in similar ways. Apart from this change there is no other obvious way in which the industry changes through time.

Comparisons with Batari and Kafiavana suggest that the similarities of Aibura are generally with Batari - the other site in the Lamari valley. In saying this I am referring to features like bases, preparatory flaking and weight which do not relate to utilised flakes. Some of the similarities may relate to difficulties in obtaining adequate supplies of good raw material, although this is hard to determine. For example, would this affect numbers of multiplane tools, percentage of pebble cortex, high number of edges? Some features clearly do not relate to this, such as number of 'whole' implements, the length of edges, the indentation indices of edges, and the chunkiness of unretouched implements. These may express in some way some regional similarity, but whether this is cultural, mechanical or imposed by the raw material is not clear.

5. Conclusion¹

The occupation of Aibura began about 4,000 years ago and continued until modern times. The character of this occupation appears to have been basically similar throughout - it was probably always occasional and sporadic in this dark, wet cave.

The early occupation (Horizon III) is marked only by some retouched implements and a few wild animal remains. The deposit seems to have been washed clear of man-made features. The flaked implements are crudely made and rather larger than those that occur later: they were not made on the site. The first ground axes occur late in this phase.

There is some suggestion that following this, the site was little used for a while. It may have been in this period that human remains were deposited in the cave.

The second phase of occupation (Horizon I) seems to have begun about a thousand years ago or less. The deposit takes on a more definite structure: ash lenses are preserved while postholes show that lean-to shelters were made. These features are rather better preserved nearer the surface. Faunal remains suggest that grasslands were increasing around the site during this late phase. A wide variety of artefacts comes from this period. Marine shell and pottery comes to Aibura from several distant areas. Manufacturing techniques include smoothing, grooving and snapping of stone and the drilling and polishing of bone

¹

A diagrammatic summary is given in Fig. 11.4.

and shell. Flaked implements are present, but were not made on the site. Within or before this period retouched tools decline in importance and become much smaller, while unretouched flakes are more commonly used. Wild animals, including birds and reptiles, continue to provide most of the meat eaten. Domestic pig and hen are scarce, while dog is absent until the most recent levels. It seems likely that for more recent times at least, this faunal picture may not truly represent the faunal resources of the people: for instance pigs may have been available for food during the entire period of occupation (see Ch. 7). Earlier occurrences of dog and fowl however remain to be demonstrated.

The cultural remains at Aibura seem to be more similar to those at Batari (also in the Lamari valley) than to sites further west. This is seen especially in the flaked stone implements, such as the rare double concave scrapers, and in the absence of waisted blades¹ and pebble tools; it is also expressed in certain attributes of the retouched tools. Similarities also occur in the small grooved and ground stone and bone artefacts of which there is a wider range at these two sites than at any other.

In general, however, the recent Aibura material was made later than anything from Batari. The village sites now being excavated in this area should provide more comparable data than anything else currently available.

¹ One waisted blade was found on the road near Barabuna village. It is made of tuff and is very weathered. It is not ground. The dimensions (in cm.) are: l_1 12.8; l_2 3.0; l_3 1.5; l_4 5.4; Br_1 6.3; Br_2 7.1; Br_3 11.9; Th_1 3.5; Th_2 3.2; Th_3 2.8.

CHAPTER 7

EXCAVATIONS AT KAFIAVANA, ASARO VALLEY1. Introduction

Kafiavana¹ is the name given by the Yagaria people of Legaiyu village to a small, high shelter on the east bank of the Fayantina² River ($6^{\circ} 15' S, 145^{\circ} 27' E$). The site lies about one mile south of the Fayantina - Dunantina junction and 12 miles S 15° E of Goroka, close to Kami estate (Map 2).

The site is within an area of Tertiary limestones, shales, greywacke and conglomerate, at the southern end of the Asaro valley.³ The surrounding country lies within the Abiera land systems whose characteristics are described as follows⁴

low hilly country of long rounded ridges and ridges with sharp crests and strongly stepped slopes, separated by long valleys with narrow swampy valley bottoms. In eastern Asaro valley ...deep brown and mottled clay to heavy clay soils. Mixed short grassland. Phragmites swamp in valley bottoms.

¹ Reference number K65.

² Or Orlowat R.

³ McMillan and Malone, 1960, Map 1.

⁴ C.S.I.R.O., 1958.

The C.S.I.R.O. report points out that this system is one of a series of old alluvial and colluvial deposits. Nearly all have long benches which look like terraces. All are completely covered with induced vegetation communities forming intricate patterns of gardens and garden regrowth, tree plantations of casuarina and bamboo and short grassland. The garden regrowth is predominantly herbaceous.¹

Kafiavana lies about half-way up the south side of Koyagu hill, an 80 m. high outcrop of highly sheared calcareous siltstone.² The hill is approximately a kilometer in circumference, with vertical rocky faces up to 30 m. high around some of the upper part.³ The lower part is covered with many large boulders. From outside the shelter there is a good view over the Fayantina valley to the south and southwest, while from the hill-top the country may be clearly seen for several miles in every direction except southeast. The shelter itself is almost invisible from any aspect today (Plates 7-1, 7-2).

The shelter is formed by a slightly overhanging cliff whose brow is some 10-11 m. above the present floor. The area sheltered is about 43 sq. metres and the maximum dimensions are 15 x 4 m. (Figs. 7.1, 7.2). There is

¹ C.S.I.R.O., 1958, p.12.

² Identified by Mr J.G. Best, Senior Geologist, Department of Mines, Port Moresby, 1965, in litt.

³ A small village existed on top of the hill before and during the period of first European contact. Several house depressions could still be seen there, including a large oval men's house. Legaiyu villagers forbade any excavation at this site.

little protection from the rain if there is any wind from the south or east. The shelter faces south so that the sun does not reach over the sill in the dry season (April-October), but comes about 1 metre inside the dripline during the wet.¹ Partial protection from the weather is given nowadays by a large clump of bamboo which grows just outside the shelter.

Human occupation of the shelter is indicated by many coloured paintings on the back wall (Plate 7-3), and a litter of stone flakes and chips on the floor. Legaiyu men said that the shelter was occupied intermittently as a refuge during pre-European conflicts.

Discovery and Excavation

Kafiavana came to my attention in 1964 when Mr J.D. Cole of Goroka² visited it as a result of hearing reports of paintings.³ The floor of the shelter was then covered with chert chips. In November-December 1964, at my instigation,⁴ Cole dug a 3 x 1 yard trench on the east side of the site. He excavated the inner square yard to a maximum depth of 85", finding flaked stone implements

¹ Information from J.D. Cole, in litt.

² Now (1967) research student in Anthropology, University of Washington. All reports are pers. comm.

³ Local reports suggest an anthropologist (name unknown) visited this site some years ago, but it has not been recorded in the literature.

⁴ This project was financed by the University of Washington Museum, by courtesy of Professor J.B. Watson.

throughout.¹ In March 1965 I inspected his material in Goroka and noted that it was similar to other Highlands flaked stone artefacts. Cole has not analysed in detail his several hundred implements, but he claims the weight of flaked implements increased with depth, while ground stone was not found below 36" from the surface.

This test excavation showed that Kafiavana contained a deep deposit with an undisturbed sequence of concentrated human occupation. Such a site was the only one reported from the Asaro valley, which lies between the Chuave-Wahgi cultural area² and the Lamari valley sites I had discovered previously. Thus as well as providing a sequence to compare with that at Kiowa, in the Chuave area,³ it was also strategically located to provide one link in an East-West transect through the Highlands.

Twelve square metres of Kafiavana were excavated by myself and Carmel White during March-May 1965. Ten of these, including the inner two of Cole's squares, were removed down to the basal sterile clay at 370-410 cm. The other two square metres (F6, F7), which lay outside the dripline, were partly removed to provide access to the trench. A total of just over 30 cubic metres of deposit was removed, and this is about one-quarter of the sheltered part of the site. I estimate that my excavation may have removed less than 10 per cent of the total volume of cultural material (Fig. 7.1).

¹ This material is now in University of Washington Museum.

² Read, 1954, p.12.

³ S. Bulmer (1966), pp.90-105.

The excavation methods are described in Chapter 3. The only spits of a depth greater than 10 cm. were removed in order to take account of the sloping stratigraphy of the lower part of the site. The rate of excavation was normally $\frac{1}{2}$ - $\frac{2}{3}$ cu. metres a day. Most of the material excavated came from inside the dripline, which ran across H4, G5 and F5-6. The location of the main column of soil samples is shown in Plate 7-8.

Stratigraphy

The visible stratigraphy of the site was not a series of finely divided layers but some major divisions were seen (see Plates 7-4 to 7-9; Figs 7.3-7.5). The units of excavation were therefore generally smaller than the observable subdivisions. There were also horizontal variations, and many features which occurred in one square were not visible a metre to the east or west. In general, however, the deposit may be divided into six main stratigraphic units.

1. 0-40 cm. below surface. Recent occupation, marked by posts and postholes, hearths and pits in the inner part of the site and an increasing humus content with many roots towards and outside the dripline.
2. 40-160 cm. below surface. An undifferentiated grey-brown (10YR 3/4 - 7.5YR 4/2) sandy silt¹ containing very little macroscopic carbon but many implements and waste flakes. Below and outside the dripline the deposit was variably concreted with calcium carbonate. The soil

¹ For exact mechanical analyses see Appendix 7.1.

was mostly damp with a marked division from the dry soil at the back of the shelter. This division was visible as a 30° sloping line which ran from the dripline at the surface to the back wall of the shelter at a depth of 150 cm. The soil in the inner part of the shelter was very soft and loose down to about one metre.

3. 160-230 cm. below surface. Heavily burnt layers of fine white, cream and red hard ash bands, containing little carbon and cultural material but some faunal remains. These ash bands were concentrated in squares G3-5 and H3-4 and faded out rapidly; they were therefore only visible in the G/H section wall (Fig. 7.4). Towards the front of the site, notably in F6 and to a certain extent in G5, cultural material was common and bone rarer. It seems likely that during the period when this level was being formed the focus of activities within the site shifted, and that this level represents the hearth and cooking area at this time with tools being made and used elsewhere. In contrast, during the period of units 2 and 4 it may be assumed that the hearth and cooking activities were elsewhere and this area of the site was used for flint knapping and other craft activities.

4. The hearth levels overlay a series of different coloured (10YR 4/1 - 10YR 3/4) silty loams which were most clearly seen in G2-G5. This material was banked up against the back wall of the shelter, so that its top was at ca 200 cm. in G2 but at ca 240 cm. in G5 (Plate 7-9). These sloping strata were not visible in the west part of H2-H4 (Fig. 7.5), where the material was so undifferentiated as to obscure any slope; they were seen in F3-F5 (Fig. 7.3), but sloped much less steeply on the

east wall. In the outer part of the site the soil was heavily concreted and could only be removed with a pick, so that any incline was obscured. These strata ended at about 310-30 cm. They contained a large amount of cultural material, much of it covered with concretions.

The relative positions of these sloping strata seemed to be undisturbed. It is however difficult to account for them in occupational terms since the slope is quite steep. It might be suggested that initially the slope was less steep but continued use of the shelter combined with slight water action and subsidence caused the front part of the site to sink, thus increasing the slope. Mr J.N. Jennings¹ states that he would expect more disturbance if this were the case, but is prepared to admit it as a possible explanation. Alternative explanations are difficult to find.

5. Below ca 320 cm. were large numbers of finger-sized fragments of the parent rock. All lay approximately horizontal and in some places were tightly packed. Patches of very fine black humus, sometimes completely stone free, and culturally sterile, were found within this level, mostly in F5 and G5. Artefacts were found within the stony areas but became less common as the parent rock fragments increased towards the base. The soil became increasingly clayey from 360 cm.

Mr Jennings comments that the fine, black, stone-free soil was possibly derived from the upper part of the hill, where a similar soil is found today. It was clearly

¹Pers. comm., 14/7/66.

associated with large pieces of parent rock which fell as a lump and shattered on impact. The merging of this fall with some parts of the surrounding deposit implies that there may have been several falls between or during periods of shelter use. The fact that some of the material is culturally sterile implies that it came from the outside and did not break up much within the deposit.

6. By 380 cm. in most areas, a stiff damp yellow-brown clay was reached. It was culturally sterile but contained many small fragments of bone. It was at least 1 metre deep and was not removed to bedrock.

This basal clay sloped upward at the back of the site and some of it clung to the back wall of the shelter up to 100 cm. below ground surface. This back wall of clay was 20-120 cm. thick and was so sharply differentiated from the cultural deposit that it almost appeared to be man-made. In squares F3 and G2 this clay formed a vertical wall 260 cm. high with a vertically corrugated surface (Plate 7-6). In H2 and on the west side of G2 the front of the wall was neither so clear-cut or vertical, but was still banked very steeply against the rock wall. A small amount of this clay was excavated but it contained only some highly mineralised bone.¹ In front of this part of the wall the soil was very crumbly, and a light creamy white in colour: it is clearly some form of weathered deposit from the front of the clay.

Mr J.N. Jennings, who has inspected sections, slides and other data, makes the following suggestions:

¹ See Appendix 7.2 for an analysis of this bone.

The clay wall has the appearance of a landslide surface. The vertical polished surface may relate to slickensiding, a phenomenon more usually seen on rock surfaces. The vertical corrugations are surprisingly regular in spacing, orientation and vertical distance covered, although the actual occurrence of a vertical surface, especially in F3 where it is aligned above a rock surface, need cause no surprise. The fact that in a few places several closely adjacent vertical faces occur implies that several different slipping planes were present. If reasonably well protected from the weather the vertical surface could remain exposed for a considerable time.

On the western side of the site, where the surface is irregular and contains small boulders, the action of the assumed slip has been different and slickensiding did not occur. This surface may be interpreted as part of the face left by the slip.

The general configuration of the hill and the presence of a stream at the base of the hill renders the landslide explanation likely, but rotational slipping, the most common cause of slickensiding, unlikely. The slickensiding may be therefore a purely local effect in a small part of the shelter.

In general terms the process of site creation was possibly 1) Buildup against rock surface of clay derived from water action on parent rock. Faunal material incorporated through various non-human causes. 2) A landslide moves most clay down ca. 4 metres where it forms a new floor. Some clay is left adhering to the back wall of the shelter. The division between original and moved clay is a complex one, with cracks and holes, and presumably some compression and slight bending by later water action. 3) Rock and soil is deposited on the new floor along with some cultural material. Later only fine natural material is deposited during the period of heavy human occupation.

Dating

The following dates have been obtained for this site.

1. The basal clay has been dated by the associated fauna to Pleistocene times. Dr M. Plane's analysis of the fauna will be found in Appendix 7.2.

2. Four radiocarbon dates are available from material in the deposit. These are:

ANU-42 4690 \pm 170 years.

This comes from wood carbon collected in G5/(5) at the base of Horizon II. Depth 50-5 cm. below surface. The carbon comes from the upper part of the humus horizon referred to by Schmid.¹ It seems to predate intensive reoccupation of the site.

RI894A² 6180 \pm 125 years (carbonate)

RI894B 9290 \pm 140 years (collagen)

These two dates are respectively the carbonate and collagen ages of 277 gm. of food bone remains collected over 8 square metres of the site. The sample lies between 200 and 270 cm. below surface, but was collected over only 50 cm. depth in any one square. The collagen date is to be preferred as closer to the true age.

ANU-20 > 9500 years

This comes from three small samples of wood carbon from three adjacent square metres of the excavation. Each sample had close internal association. Depth 250-70 cm.

¹ See Appendix 7.1

² These dates are from the Institute of Nuclear Sciences, New Zealand. Final reference numbers have yet to be allocated to them.

below surface. The ANU laboratory advises that the sample was very small and 'only the younger age limit is relevant'.¹

ANU-41a	$\geq 6750 \pm 100$ years (carbonate)
ANU-41b	$\geq 10730 \pm 370$ years (acid insoluble fraction)

These dates are the carbonate and collagen ages of a 500 gm. sample of unidentifiable food bone remains collected from 260-310 cm. below surface over 6 sq. metres of the site. The ANU Laboratory points out²

after the carbonate had been evolved, the residue was allowed to settle and the excess acid washed off. The residue was then oven-dried and combusted to give sample 41b. This is referred to as 'collagen', but is more accurately called the 'acid insoluble fraction'. It is generally agreed that this substance gives a valid date, but we agree with Tamers in considering it is more reasonable to think of this date as equal to or greater than the age given.

Sediment analysis

Twenty one sediment samples were submitted to Professor E. Schmid³ for analysis. The detailed report by Professor Schmid and Dr Grüniger is in Appendix 7.1.

¹ Report on Radiocarbon Age Determination, 15/12/66.

² Report on Radiocarbon Age Determination, 5/6/67.

³ Professor of Early Prehistory, Laboratorium für Urgeschichte, Universität Basel. I am most grateful to Prof. Schmid for undertaking this work and for her continuous cooperation.

The samples consist of one basal clay sample and twenty samples from a column taken from the west wall at the south end of H3. The column was 10 cm. wide and samples, numbered from the bottom up, were taken at every alternate 10 cm. The analysis consists of mechanical sorting and chemical tests. The mechanical analysis shows that the soil throughout is a silty sand. Below ca 250 cm. it contains a proportion of small gravel, and a few elements of this kind are also found near the surface. The samples above the basal clay all have a fairly constant amount of phosphate but a widely varying humus content.

On the basis of these analyses and employing certain general principles Schmid and Grüniger divide the deposit into six zones. The basal clay was, they think, formed in water and laid down under pluvial conditions. The other sediments exhibit evidence of five different climatic phases, with three humid periods being interspersed with two dry ones. The 'dry' samples occur at 295-155 cm. and 95-35 cm., and Professor Schmid argues that the lower of these two samples must record a dry period during deglaciation subsequent to 10,000 B.P.

They also draw attention to three interesting items:

(i) Small fragments of snail shell occur in many samples. If the climatic requirements of each snail species were known, the representation of species at a certain time might permit climatic - or at least micro-environmental - interpretations to be made.

(ii) Samples 3-20 (above 325 cm.) all contain very small flakes (down to 0.1 mm. diameter) of siliceous

materials. The presence of these indicates that flaking was carried out at and above this level. It will be seen later in this chapter that the artefacts from the lowest horizon, into which samples 1 and 2 fall, exhibit a number of differences from the artefacts above. These facts may be related. It also seems to me, that by studying the relative number of these micro-flakes, some determination of the local intensity of flint-working could be made and workshop areas within the site delineated.

(iii) The high humus content of samples 14-16 may indicate that the site was abandoned for some time. I will argue later on archaeological grounds that there may be some break in deposition at about this level, with the material in the top two horizons being deposited in more recent times. There is apparently some accord between archaeological and geological inferences.

Whether Professor Schmid's climatic interpretations are valid is something for soil scientists and palaeoclimatologists to discuss. Messrs J.N. Jennings and R.M. Frank¹ consider that it is premature to make climatic inferences and even the local conditions during deposition cannot be clearly derived from the analyses given. Their comments are also given in Appendix 7.1.

The analyses by Professor Schmid and Dr Grüniger are the first to be made of the sediments in New Guinea shelter. They give a valuable and detailed description, which confirms and supplements the field observations. In

¹ Dept. of Geography, I.A.S., Australian National University.

particular aspects, their data is helpful in considering certain problems. Even if certain aspects of the interpretation are disputed the report will perhaps provide a stimulus to further research.

Division of the material

For the purposes of analysis the artefactual material has been divided into nine arbitrary horizons numbered from the surface down. These divisions attempt to take account of the concentrations of artefactual material, and the need to have approximately equal numbers of implements and equal volumes in each horizon. Of these three factors the first was clearly the most important since this was the only feature which derived directly from the distribution of the material.

It will be seen from the scatter-plots (Figs 7.6, 7.7) recording the position of implements which were recognised in the field (55 per cent of the total implements) that three main concentrations occurred within the site. These were obscured towards the back wall (squares F3, G2, H2) and seem to be different in F6, probably for reasons already explained.¹ These three concentrations, which were clearest in F5, G3-4 and H3-4, show increases in stone-tool working at these parts of the site. These concentrations can also be seen in the distribution of waste stone in the site (Figs 7.8, 7.9).

The nine horizons do not cut across the concentrations of material so that, for example, both

¹ See p.257.

concentrations and horizons tend to slope slightly down towards the front of the site. The small uppermost implement concentration is placed within Horizons I-II, while Horizons III-V include the main upper concentration. Horizon VI contains the more sterile intermediate zone around 160-210 cm., but also includes the large number of implements from square F6. The lower concentration of implements lies in Horizons VII-VIII, while all basal material is found in Horizon IX. The density of implements per cubic metre is set out in Table 7.1.

It must be pointed out that these horizons are fairly broad units which contain from 1.5 to 4.5 cu. metres of deposit. This is a deliberate attempt to avoid drawing fine divisions, which neither the visible stratigraphy nor the theory of disturbance due to human treadage and scuffage within heavily occupied sites¹ will support. These broad units are derived from the detailed implement plots and it would not have been possible to recognise the concentrations of implements without an initial precise recording of implement locations. The absence of ground-edge axes and axe chips in Horizon VI also clearly marks a break between upper and lower artefact concentrations.

For certain parts of this analysis only some of the squares are included. Thus in the standard typology the three back squares (F3, G2, H2) are omitted because of possible greater admixture in the loose soft soil and the banking up of material against the back wall. Also, some questions in the attribute analysis were asked of squares

¹ Matthews (1964), pp.167-71.

F5, G3-4 and H3-4 only, as it seemed worthwhile trying to discover if the implements which were clearly in different concentrations showed different characteristics. In all cases however the division into nine horizons was retained. Table 7.2 shows how the excavated spits in each square are distributed among horizons.

Table T.1.1 Concentration of implements per cubic metre¹

Square	HORIZON									
	I	II	III	IV	V	VI	VII	VIII	IX	
P3	116	165	242	36	70	107	60	80	10	
P4	X	X	X	X	X	X	35	51	37	
P5	X	X	X	X	25	12	17	33	13	
P6	X	X	X	37	164	167	X	X	X	
P7	X	X	9	5	X	X	X	X	X	
Q1	146	168	38	75	4	15	31	X	X	
Q3	129	91	157	64	29	52	105	35	X	
Q4	63	68	128	130	100	30	36	85	15	
Q5	25	14	93	68	64	70	16	90	8	
Q2	88	360	260	150	110	40	33	X	X	
H3	100	120	147	100	48	44	117	66	2	
H4	55	15	65	166	89	13	34	63	2	
TOTAL	94	118	100	300	71	49	47	52	11	
Number of implements Volume (cu. metre)	161	226	351	284	325	432	265	202	45	
	1.75	1.90	3.51	2.83	4.6	3.95	3.51	3.85	4.27	
										TOTAL
										1954
										30.17

¹ Calculated by dividing number of implements per horizon per square by volume of deposit in that unit.

Table 7.2 . Spits attributed to horizons

Square	Horizon									
	I	II	III	IV	V	VI	VII	VIII	IX	
F3	1-3	4-8	9-14	15-21	22-26	27-29	30-35	37-51	52-56	
F4	-	-	-	-	-	-	1-6	7-12	13-20	
F5	-	-	-	-	1-6	7-11	12-16	17-21	22-26	
F6	-	-	1	2-3	4-7	8-14	-	-	-	
F7	-	-	1-3	4	-	-	-	-	-	
G2	1-5	6-9	10-13	14-17	18-22	23-26	27-30	31-33	-	
G3	1-2	3-6	7-11	12-17	18-25	26-31	32-38	39-45	-	
G4	1-3	4-5	6-10	11-16	17-23	24-31	32-38	39-43	44-50	
G5	1-2	3-5	6-8	9-14	15-22	23-27	28-33	34-39	40-44	
H2	1-3	4-8	9-14	15-20	21-23	24-25	26-28	29-41	-	
H3	1-3	4-8	9-14	15-20	21-26	27-31	32-35	36-41	42-46	
H4	1-2	3-6	7-12	13-18	19-27	28-34	35-41	42-47	48-50	

2. Fauna and Flora1) Domestic animals¹

Pig (Sus scrofa Linnaeus) was the only domesticated animal found. Most remains came from Horizon I, but some occurred down to Horizon IV and possibly to Horizon V. They were found both behind and outside the dripline. On a within-horizon basis, at least six animals including one piglet, are represented. Most of the bones are very broken and are insufficient for metrical study. About half the pieces are teeth, mostly molars, and phalanges are also common.

Table 7.3 : Pig remains

Horizon	Fragments	Min. animals
I	58	>4
III	1 lower incisor	1
IV	m ² (very worn)	1 + 1?
	m ³ ? (unworn)	
	1 prox. humerus (broken)	
V	? astragalus (broken)	1?
Total	63	>6 + 2?

It is assumed that the animals are domestic, but they may have been feral.

¹

I am grateful to Mr C.L. Cram, ex-Department of Anthropology, A.N.U., for help with these identifications.

2) Wild animals

The following animals have been identified:

Macropodidae	: <u>Thylogale bruijini</u> (Schreber)	Scrub wallaby
	: <u>Dendrolagus sp.</u>	Tree kangaroo
	: <u>Dorcopsulus sp.</u>	Wallaby
Phalangeridae	: <u>Phalanger spp.</u>	Cuscus
	sub-genus <u>Pseudocheirops spp.</u>	Large ring-tailed phalanger
	sub-genus <u>Pseudocheirus spp.</u>	Small ring-tailed phalanger
Peramelidae	: <u>Peroryctes sp.</u> or <u>Echymipera sp.</u>	Bandicoot
Dasyuridae	: <u>Satanellus albopunctatus</u> (Schlegel)	Native 'cat'
Megachiroptera:	Cf. <u>Pteropus sp.</u>	Flying fox.
Muridae	: <u>Hyomys goliath</u> (Milne-Edwards)	Giant rat
	: <u>Uromys sp.</u>	Giant naked-tailed rat
	: Small unidentified genera	
Tachyglossidae:	<u>Zaglossus sp.</u>	Echidna

These identifications are based on mandibles and maxillae only, except for the Echidna which is identified by a spine.

The total number of animals is 95. This is calculated from the mandibles and maxillae on a within-horizon basis. A distinction has been made between adult and juvenile dentition where possible.

Table 7.4 demonstrates that the bulk of the identifiable fauna is made up of macropods and cuscus,

with a few bats and small mammals comprising the remainder. About twenty seven (28 per cent) of the animals have not been identified.

The number of animals from this site is too small for any significant conclusions to be drawn. However, there does not seem to be any radical change in the fauna represented nor are there enough animals which are sufficiently specific in their environments to allow detailed environmental changes (if any occurred) to be observed.¹

The concentration of animals at different levels varies. If anything, animals and implements tend to be positively correlated so that there are rather more animal remains in horizons where implements are more common. This is not true of Horizon VII which has a small amount of all kinds of animal remains but contains the upper part of the lowest implement concentration.

It is evident that domestic animals only become important in Horizon I, where they form about 1/3 of all animals. Although quantitative studies are lacking, it might be assumed that this is a reasonable representation of their importance, particularly at a site which is likely to have been occupied sporadically by husbandmen. Whether this sudden increase in the importance of pigs goes with other economic changes remains to be demonstrated.

The small number of animals found throughout the deposit is surprising and unlike other sites excavated,

¹ See Appendix 3.1.

with the exception of Omkombogo. The most likely explanation seems to be that much bone was either destroyed or thrown out of the shelter by its occupants. Most bones in the excavation are very broken and splintered, while nearly all of them are burnt to some extent. It should also be noted that even where many hearths occurred in combination with a slight decline in stone-working there is little alteration in the amount of bone present. This suggests that the low quantities of bone are not restricted to the excavated part of the site. The distribution of post-cranial bones is given in Tables 7.5-7.7, and its concentration in Table 7.8.

Table 2.3 : Wild animals - minimum numbers.

	Months									
	I	II	III	IV	V	VI	VII	VIII	IX	Total
Meleagridae	2	-	2	2	3	3	-	2	2	18
Phalacrocoracidae : <u>Phalacrocorax sp.</u>	1	2	2	-	4	2	-	5	1	15
sub-genus <u>Pseudophalacrocorax</u>	-	-	1	-	2	-	-	-	1	4
sub-genus <u>Pseudophalacrocorax</u>	-	1	-	-	1	-	-	1	-	3
sub-genus <u>Pseudophalacrocorax</u>	-	-	2	1	-	1	-	-	-	4
sub-genus <u>Pseudophalacrocorax</u>	-	-	-	-	1	1	-	-	1	3
sub-genus <u>Pseudophalacrocorax</u>	-	1	1	1	1	-	-	2	2	8
sub-genus <u>Pseudophalacrocorax</u>	1	-	2	-	-	-	-	-	-	3
sub-genus <u>Pseudophalacrocorax</u>	-	-	-	-	1	-	-	-	1	2
sub-genus <u>Pseudophalacrocorax</u>	1	-	2	1	-	-	-	2	1	7
sub-genus <u>Pseudophalacrocorax</u>	-	-	-	-	-	-	-	-	1	1
sub-genus <u>Pseudophalacrocorax</u>	4	1	2	3	8	6	1	1	1	27
sub-genus <u>Pseudophalacrocorax</u>	9	5	15	8	23	13	1	11	11	95
sub-genus <u>Pseudophalacrocorax</u>	5.2	2.6	4.0	2.8	3.0	3.3	0.3	2.9	2.6	3.15

Table 7.5 - Identifiable semi-cranial bone - number

Horizon	F3	P4	F5	F6	F7	G2	G3	G4	G5	III	R3	IN	TOTAL
I	13	-	-	-	-	53	5	7	5	8	-	1	92
II	45	-	-	-	-	49	7	1	6	43	11	1	163
III	42	-	-	-	42	49	10	8	-	149	14	2	316
IV	16	-	-	6	13	39	30	7	3	86	21	17	238
V	30	-	1	10	-	12	91	29	35	134	92	35	489
VI	20	-	6	24	-	7	38	29	4	14	52	22	196
VII	2	3	7	-	-	2	12	2	3	10	13	18	74
VIII	7	12	26	-	-	8	52	16	20	16	58	26	265
IX	18	37	26	-	-	-	-	91	24	-	39	69	324
TOTAL													2137

Table 7.6 : Identifiable post-cranial bones - weight in gm.

Horizon	P3	P4	P5	P6	P7	O2	O3	O4	O5	H2	H3	H4	Total
I	5.7	-	-	-	-	26.1	3.6	2.4	1.4	12.5	-	1.4	52.9
II	15.0	-	-	-	-	15.6	2.1	0.1	3.7	20.0	7.4	0.5	62.4
III	16.6	-	-	-	17.4	11.3	2.7	1.2	-	55.2	3.3	0.3	102.1
IV	3.1	-	-	3.8	3.6	17.2	8.5	3.3	2.0	29.4	6.5	8.2	97.6
V	10.5	-	0.4	3.3	-	4.4	18.6	7.4	8.2	28.4	26.6	12.4	120.4
VI	6.7	-	3.2	7.4	-	1.3	10.5	11.9	1.4	3.1	6.8	4.7	57.0
VII	0.3	0.7	2.5	-	-	0.3	2.6	1.3	2.8	2.0	2.9	3.7	21.3
VIII	1.3	11.4	15.3	-	-	5.8	25.7	4.0	18.3	3.1	12.6	7.7	97.4
IX	4.6	17.5	22.9	-	-	-	-	20.0	12.0	-	6.1	16.9	110.0
Total													751.1

Table 7.7 : Unidentifiable bones - weight in gm.

Horizon	P3	P4	P5	P6	P7	O2	O3	O4	O5	H2	H3	H4	Total
I	91.0	-	-	-	-	297.9	29.6	21.3	20.4	26.3	32.3	10.5	439.5
II	78.9	-	-	-	-	94.6	28.5	7.0	7.7	120.4	17.5	8.2	328.8
III	42.1	-	-	1.3	19.3	77.0	20.9	7.0	3.3	237.8	20.4	4.2	445.3
IV	29.2	-	-	29.9	21.0	14.0	79.7	28.7	10.4	229.5	14.5	13.9	340.0
V	126.6	-	10.2	23.2	-	43.2	177.8	124.5	29.8	216.9	223.2	169.4	1159.8
VI	86.6	-	37.5	162.1	-	15.4	261.7	114.9	24.8	35.9	72.0	101.2	772.1
VII	11.4	27.3	24.4	-	-	6.3	31.8	46.3	7.5	16.3	42.4	26.1	223.8
VIII	9.4	22.1	24.3	-	-	27.3	71.1	26.8	79.4	24.0	29.9	22.4	458.7
IX	20.7	64.2	43.5	-	-	-	-	120.2	21.8	-	48.4	112.9	413.7
Total													5025.7

Table 7.8 : Concentration of unidentified bone

Horizon	Gm/cu. metre
I	254
II	187
III	184
IV	194
V	251
VI	268
VII	67.8
VIII	119
IX	96.8
Mean	174

3) Fish

One fish vertebra was found in Horizon IV. It has not been identified but is probably of a freshwater species. Three broken shark's teeth were found in Horizon II. They were probably used for decoration, but show no traces of working. Some very small fragments of fishbone were found by Prof. Schmid, so that more fish may have been taken to the site than can now be found.

4) Birds

Only a few fragments of bird bone were seen. A little cassowary bone may have been mistakenly classed with mammal bone but most bone clearly did not belong to such a large animal.

Eggshell occurred throughout the site. Cassowary shell was concentrated in Horizon III and particularly in

square H2, but even there there was only sufficient for 1/8 of an egg.

Other eggshell, probably of brush turkey (Aepyodius sp.) or other large birds, was found in limited quantities throughout the site.

None of the shell has been worked in any way.

Table 7.9 : Eggshell

Horizon	Cassowary		Other
	Number	Weight (gm.)	Number
I	2	0.2	1
II	7	1.7	2
III	50	10.3	4
IV	6	1.7	2
V	4	0.9	22
VI	1	0.2	5
VII	-	-	3
VIII	-	-	2
IX	-	-	1
Total	70	15.0	42

5) Reptiles

All eleven reptile fragments identified by Dr Barwick are from lizards. Seven (minimum of 4 animals) are from Agamid lizards, one is from a sharp-snouted lizard and the other three are not further identifiable. The fragments were scattered through the site, viz. Horizon I, 2; III, 2; IV, 2; V, 3; IX, 2. These animals were presumably eaten.

6) Mollusca

Mollusca from three environments - marine, freshwater and land - were found throughout Kafiavana. The only naturally occurring types are probably some land snails, which were common in the basal clay and probably crawled into the site from time to time. All mollusca have been identified by Dr McMichael.¹ The number of specimens from each environment is listed below.(Table 7.10).

a) Marine mollusca

Four genera of marine mollusca have been identified by McMichael. One other genus Stenomelania sp. may be marine but some species live in freshwater in higher country. One specimen is identifiable only to class level.

The most interesting fact about the marine mollusca is the presence of four Cypraea moneta shells in Horizon VII. This documents trade with the coast some 9000 years ago, which is much earlier than had been suspected previously.

The single specimen from Horizon IX may also mark trade with the coast, but it may belong to Stenomelania or some other environmentally less restricted mollusc.

None of the specimens come from a particular coast.

¹
In litt., 9/8/66.

Table 7.10 : Mollusca - number

	I	II	III	IV	V	VI	VII	VIII	IX	Total
Marine	5	3	3	1	-	-	4	-	1?	16+1?
Freshwater	2	5	-	2	6	6	-	-	-	21
Land	1	1	5	5	14	4	4	10	10	54
Unident.	-	1	3	-	-	4	1	-	1	10
Total	8	10	11	8	20	14	9	10	11+1?	101+1?
No./cu. metre	4.6	5.2	3.1	2.8	4.3	3.5	3.6	2.6	2.8	3.4

Table 7.11 : Marine mollusca - number

	I	II	III	IV	V	VI	VII	VIII	IX
<u>Geloina</u> spp. (estuarine bivalve)	3	2	2	1	-	-	-	-	-
<u>Oliva</u> sp. (Olive shell)	1	-	-	-	-	-	-	-	-
<u>Nassarius</u> sp. (Dog Whelk)	-	-	1	-	-	-	-	-	-
<u>Cypraea moneta</u> L. (Money Cowry)	-	1	-	-	-	-	4	-	-
<u>Stenomelania</u> sp.	1	-	-	-	-	-	-	-	-
Class <u>Gastropoda</u>	-	-	-	-	-	-	-	-	1

b) Freshwater mollusca

All these shells belong to freshwater mussels (Family Hyriidae) which are common in Highland streams. All specimens are very fragmentary, and none were identified to species level. None show signs of working or use.

c) Land mollusca

All land mollusca are snails of the Camaenid family which McMichael says live locally. The presence of some snails is probably fortuitous, and none of the shells show any signs of human activity. One Chloritis spp. has been identified in Horizon I and 4 Papuina spp. came from Horizon IX, possibly from an unoccupied section of the site.

d) Conclusions

Table 7.10 shows that mollusca were a constant component of the material at Kafiavana. However, it is apparent that marine shells became more common in the upper part of the site, suggesting an increasing trade with the coast. This trade has clearly been in existence from the early period of occupation.

It is difficult to suggest whether other shells were used as decoration or tools or are food remains. On ethnographic grounds they may be tools,¹ but no signs of use have been observed on these specimens.

¹ S. and R. Bulmer, 1964, p.56.

7) Human remains

Eleven pieces of human bone were discovered scattered through the site. Four of them were close together in Square G5, Horizon V, but no signs of a pit were seen. The other bones were not in association. These bones have been identified by Mr A.G. Thorne:¹

H2/(2), Horizon I. Two-thirds of the crown of a lower PM. The tooth is heavily worn with substantial exposure of the dentine.

H2/(12), Horizon III. Five fragments of human bone, not further identifiable.

G5/(10), Horizon IV. A terminal phalange from a hand; from one of the three middle fingers.

76.G5/(15),² Horizon V. A lumbar vertebra, highly encrusted with calcium carbonate.

77.G5/(16), Horizon V. Clavicle - right, adult. It is fairly robust.

G5/(17), Horizon V. One middle phalange of a hand and one tarsal bone (not further identified).

These scattered bones were not primary burials; whether they were accidentally or purposefully deposited at the site is not known.

¹ Department of Anatomy, University of Sydney.

² Reference number.square/(spit).

8) Vegetation remainsi) Pollen Analysis

Four samples were submitted to the Department of Geography, A.N.U. Their reference numbers and levels are:

20:	0- 10 cm.	below surface		
18:	22- 32 cm.	"	"	
17:	42- 52 cm.	"	"	
9:	200-210 cm.	"	"	

All samples were studied by Miss J. Wheeler and Mr W. Litchfield, whose report appears in Appendix 7.3. Briefly, they state that pollen is present in sample 20 though in very low concentrations, probably due to a continued highly oxidising atmosphere in the shelter. Some grass and tree pollen was recorded, but Ipomoea batatas was not seen.

It is apparent that even if pollen were extracted much of it would be difficult to identify and if it were identified little accurate environmental data could be deduced from it.¹ It is also difficult to find an expert analyst who is prepared to work on this material.

ii) Macroscopic vegetable matter

Three kinds of material were found, all of them showing aspects of man's activity at the site.

As might be expected, all examples came from the upper part of the top horizon, and even then some specimens are very decayed.

¹ Dr D.M. Walker, Dept. of Geography, I.A.S., Australian National University, pers. comm.

1) The lower parts of fourteen wooden stakes were recovered. These were usually sharpened at one end and had the other end cut off square and/or carbonised. The lengths range from 3.7 to 18.5 cm. and diameters range from 1.3 to 2.5 cm., mostly being 1.5-2.0 cm. All appear to be made of straight branches, with twigs broken off but the bark left on.

Eleven stakes were found in G2 and H2, and the other three were in H3 and H4. No pattern could be seen in their distribution, but three were clustered together in H2. The top of one stake was 10-15 cm. below ground surface but all others were at or just below the surface. The wood of these stakes has been identified by Dr R. Muncey.¹ Three are certainly Casuarina and 'could well be' the common species Casuarina oligodon. Two others are possibly Casuarina. One is a Pittosporum, possibly P. ferrugineum, a common small tree. Two are Monocotyledons and could be bamboo while the remaining six are from three different genera of dicotyledonous trees.

No information was available locally as to the use of these stakes. Most of them are so close to the rock wall that a lean-to shelter is unlikely. Their carbonised tops possibly suggest that they are related to cooking.

2) Three small pieces of bark cloth were found on and just below the surface. This is similar to normal Eastern Highlands material in use today.

¹ Division of Forest Products, C.S.I.R.O., in litt., 30/9/66. Dr Muncey's help in this work is gratefully acknowledged.

3) One flattened sleeve of fibre binding was found on the surface of the site prior to excavation. Five centimetres long and of conical shape (diameters at top and base 1.2 and 1.9 cm.) it is similar in every respect to the binding made over the junction of a bamboo arrowhead and its shaft (see Ch. 4).

4. Artefacts

1) Axe-adze

Fifty three whole and fragmentary axe-adzes were found, some in every horizon except VI. Thirty eight of these specimens show signs of grinding.

All whole axes and most large fragments were found in the upper part of the front of the shelter, outside the dripline in squares F6 and F7.

Nearly all axes whose shape is determinable are lenticular in cross-section (angle of sides $60-75^{\circ}$), and taper towards the butt. One axe from Horizon III has narrow ground sides and might be called planilateral. Three have a pointed butt, all other butts being squared-off in plan. The cutting edges are normally slightly curved in plan, with a fairly sharp corner at each end of the blade.

Few axes are heavily ground and many, particularly those from the upper part of the site, are coarsely flaked from river pebbles and have considerable cortex remaining on them. Two roughouts were found on the surface. There is no other change visible in the axe types throughout the deposit.

The stone used¹ includes several varieties of hornfels, greywackes and meta-greywackes, as well as micaceous nephrite, andesite and slate. Most pieces do not come from identifiable quarries and were probably collected from the Fayantina River gravels. Two pieces, on each from Horizons II and III, come from the Kafetu hornfels quarry² about 30 miles northwest of Kafiavana, near Daulo Pass.

Table 7.12 sets out the data about the axes, and each axe-adze is described below.

Surface

2 ? roughouts, being coarse chunky axe-shaped objects partly flaked out of river pebbles.

1 ? cutting edge and body³ section, coarsely flaked from river pebble. Cutting edge is straight and at right-angles to the sides. Lenticular cross-section.

1 U-shaped butt flaked from a river pebble. Lenticular cross-section. Width 5 cm., thickness 2.6 cm.

Horizon I

13.G5/(7). Section of body of long thin axe, tapering slightly towards butt end. Flaked all over. Width 5.8 cm., thickness 2.0 cm.

¹

This and other identifications of axes by Mr J.M.A. Chappell.

²

Salisbury, 1962, p.85; J. Chappell, 'Stone Axe Factories in the Highlands of East New Guinea', Proceedings of the Prehistoric Society, n.s., XXXII, 1966, p.104.

³

I.e. section of axe blade between cutting edge and butt.

3.G3/(1). Squared-off butt, partly polished.
Lenticular cross-section with ground bevel on each side.

1.G5/(1). Curved section of symmetrically bevelled, ground cutting edge. Only the bevels are ground. Angle of edge 60°.

G2/(3), 6.G4/(3). Two chips, partly ground.

Horizon II

34.F3/(5). Very small (3.4 x 2.0 x 0.6 cm.), very asymmetrically bevelled axe-adze, with only the cutting edge bevels ground. Lenticular cross-section. Dark green micaceous nephrite.

9.G5/(5). Part of a body and cutting edge of small axe made from a chip off a river pebble. Approximately triangular cross-section. Partly ground near blade. Cutting edge straight and asymmetrically beveled, with sharp corners to sides. Width 2.3 cm., thickness 0.7 cm.

54.F3/(8). Squared butt and part of a body of a flaked axe in hornfels. Lenticular cross-section. Width 4.7 cm., thickness 1.9 cm.

15.G4/(6). Small section of thin ground body in brown slate. Lenticular cross-section, but very thin (maximum thickness 0.4 cm.). Grinding marks are multi-directional.

Two wholly ground chips: F3/(6), H3/(7).

Seven partly ground chips 7.H4/(3), H3/(5), H4/(4), H4/(3), G3/(6), G5/(3), 42.G2/(7).¹

¹
From Kafetu quarry.

One unground side fragment showing lenticular section:
6.H4/(3).

Horizon III

F6/(1) (Fig. 7.12b). One whole axe flaked from river pebble. One thick squared-off side is made of cortex, the other side is flaked into a lenticular shape. The butt is tapering and squared-off at the end. Cutting edge is straight and symmetrically bevelled, but set slightly skew when viewed end-on. Length 15.5, width 5.7, thickness 2.7 cm.

F6/(1)i. Body and cutting edge of axe very similar to F6/(1). Parallel sides and unground. Width 4.7 cm., thickness 2.7 cm.

5.F7/(2). Butt end part of lenticular, partly ground axe-adze. The butt is squared off, the sides taper very slightly towards it. Width 4.4 cm., thickness 1.2 cm.

2.F7/(1). Slightly squared off end of a tapering butt. Flattened-oval cross-section with ?? pecked sides. Pebble cortex over much of surface and unground.

3.F7/(1). Small square tapering butt. Ground all over one face and most of other. The cross-section tends towards planilateral, with 0.25 cm. wide ground sides.

One unground (F7/(1)) and four partly ground chips (F7/(3), 6.F7/(2), 7.F7/(2), 92.F3/(14)¹).

¹

From Kafetu quarry.

Horizon IV

F6/(3B). Parallel-sided chunk of river pebble with flaking along both sides. Plano-convex section, semi-rounded butt. Cutting edge broken off. Width 5.6 cm., thickness 2.9 cm.

3.F6/(2A). Butt part of axe similar to F6/(1). Bifacially flaked on one side, cortex on other side so cross-section very asymmetrical. Butt squared off. Meta-greywacke. Width 5.6 cm., thickness 3.2 cm.

10.F6/(2B). Pointed butt of lenticular cross-sectioned axe, only slightly ground on one face.

Three large chips, two unground and one partly ground (F6/(2A), 12.F6/(3B), F7/(4A)).

Horizon V

14.F6/(4B) (Fig. 7.11b). Small axe flaked from river pebble. Widest towards cutting edge, which is curved in plan. Body tapers towards the butt, which is squared off. Lenticular cross-section. Slightly ground on both faces. Length 8.8 cm., width 4.2 cm., thickness 1.4 cm.

Horizon VII

194.H2/(37). Large chip of probably pointed butt. Slightly ground on one face. Greywacke.

H2/(35). Small, bifacially flaked butt, rounded rather than squared off.

H4/(41) and G3/(37). Two chips from one side of lenticular cross-section axe. Side is slightly rounded,

with double bevel caused by grinding. Angle of edge ca 70-75°.

Five chips with grinding. One is an edge, angle 60° (G3/(36) (3 frags), G3/(37), H3/(34)).

Horizon VIII

H3/(36). Curved chip of ? body. Side is ground from both faces, but one bevel is very close to parallel with a face. Heavy retouch chipping has removed part of the edge. Angle of edge ca. 60°.

H3/(36). Ground side chip, angle ca. 60°. Very similar to two curving chips from Horizon VII.

F3/(49). Partly ground side chip, angle ca. 65°.

Horizon IX

G4/(47) (Fig. 7.12a). Large chip of (probably) cutting edge. Very asymmetrically bevelled and heavily ground. Made from river pebble. Angle of edge 63-67°. Fragment measures 3.7 x 3.2 x 1.0 cm.

135.H4/(50) (Fig. 7.11a). Very pointed butt of andesite with many hornfels inclusions. The fragment is flaked from river pebble, lenticular in cross-section and very heavy. Sides taper to pointed butt. Length 8.0 cm., width 7.3 cm., thickness 3.9 cm. One side is much more heavily flaked than the other. This must have been a very large implement. It may correspond to S. Bulmer's class of 'biface',¹ but appears to be rather thicker.

¹ S. Bulmer (1966), Fig. 16.

Table 7.12 : Kafilavana - axe-adzses

Horizon	Total	No. with grinding	Whole	Butt	Body	Cutting edge	Chips	Rough-out	No./cu. metre
Surface	4	4	-	1	-	1	-	2	-
I	5	4	-	1	1	1	2	-	2.9
II	14	11	1	1	1	1	10	-	7.3
III	10	7	1	2	-	1	5	-	2.9
IV	6	4	1	2	1	-	3	-	2.1
V	1	1	1	-	-	-	-	-	0.2
VI	-	1	-	-	-	-	-	-	-
VII	8 ^y	7	-	2	1	-	5	-	2.3
VIII	3	3	-	-	1?	-	-	-	0.8
IX	2	1	-	1	-	1?	-	-	0.5
Total	53	38	3	11	4+1?	4+1?	27	2	1.8

2) Pottery

One piece of hand-made pottery was found on the surface of the site prior to excavation. This rim sherd is reddish in colour and made of fine clay with occasional lumps of coarse filler. The rim is horizontally everted with finger indentations around the edge. On the body of the sherd below the neck the decoration consists of 3 series of three or four irregularly spaced incised lines set about 5-20° off vertical in continuous chevron pattern. In the spaces between are depressions probably caused by jabbing a stick or some other sharp object into the wet clay.

The rim would have been about 25 cm. in diameter. The thickness of the sherd at the rim is 9 mm. but away from it thins down to 5 mm.

This sherd differs in form or decoration from the Agarabi¹ or the Markham² pottery which has been recorded. Mr C.A. Key has made a thin section of this pot and reports that petrographically it is not similar to Markham or Agarabi sherds available for comparison. It is however very similar to Aibura sherd 239.XIII/(3). It is possible that both these sherds come from a potting centre in the upper Markham area from which comparative material is not yet available. Several Legaiyu men said that pottery came to them from the upper Bena Bena River area.

¹ Watson, 1955, p.124.

² Holzknecht, 1957.

3) Bone Tools

Twenty two bone tools and fifteen pieces of worked bone were found. With one exception, all these artefacts were found towards the back of the site, near the shelter wall. They were concentrated in the middle levels of the site, between Horizons III and VII. None occurred in the lowest horizons and only two in the top two horizons, as Table 7.13 shows.

Three main classes of points have been defined, while four tools are described separately. There is no apparent change in the proportion in each class over time.

i) Broad flattish points (Fig. 7.10b)

These six tools are made from slivers of long bone or from ribs. They are very asymmetrical in cross-section and have rounded ends rather than sharp points. The most complete one is pieced together from fragments in two spits and is highly polished, but it gives no hint of the shape of the other end. These points are similar to Batari, class 1 points.

ii) Medium asymmetrical points (Fig. 7.10d-f)

The characteristic feature of these eight points is that the tip is formed by cutting across the medullary cavity of a shaft so that the tip is formed on one side. In most cases the points are broken off; the one which is whole is not very finely pointed. These points are made in the same way as present-day needles, but are much thicker and heavier. G2/(24) from Horizon VI is considerably larger than other examples of this class.

iii) Thin fine points (Fig. 7.10g)

These three fine points are very similar to present-day needles.

Four bone tools are worth recording separately:

Horizon V: G3/(18) (Fig. 7.10a). A very large flat spatulate point made from a splinter of long bone. Length 60 mm., maximum thickness 10 x 3 mm. The tip appears to be broken, perhaps by chewing? The remaining section is highly polished.

Horizon VI: H3/(29), H3/(30). Two flat points made from long bone splinters cut sharply from each side to form an angular tip. One is only a tip, the other is 32.5 mm. long with a thickness of 3 x 1.5 mm.

Horizon VII: H3/(33) (Fig. 7.10c). A broken ?metapodial with a 3 mm. diam. hole worked through the shaft just below the proximal end. There are no signs of drilling around the hole but both bone surfaces show a number of lateral scratches leading into it. The shaft of the bone is broken. This was probably a pendant of some kind.

Table 7.13 : Bone tools - number and distribution

Horizon	I	II	III	IV	V	VI	VII	VIII	IX	Total
Class 1: Broad, flat points	-	-	2	1	2	-	1	-	-	6
Class 2: Medium, asymmetrical points	1	-	2	2	2	2	-	-	-	9
Class 3: Thin, fine points	-	-	1	-	-	2	-	-	-	3
Other tools	-	-	-	-	1	3	-	-	-	4
Broken, worked pieces	-	1	5	3	3	1	2	-	-	15
Total	1	1	10	6	8	8	3	-	-	37

Table 7-14. Bone Points - Measurements.

Class	Horizon	No.	Length cm.	Thickness ¹ in mm.	Comments
1	III	H2/(12)	2.1	Broken	Max. thickness 5x2.5 mm.
1	III	F2/(2)	1.1	2x1.5	
1	IV	G2/(14a)	1.85	2x1	Max. thickness 2x1.5 mm. Max. thickness 5 mm.
1	V	H2/(27a)	2.5	Broken	
1	V	H2/(23a)	5.1	4x1.5	
1	VII	H3/(25)	1.5	Broken	Length of cut (mm.)
2	L ₀	G2/(5)	2.0	3.5x3	
2	III	G2/(10)	2.45	2x2.5	12.5
2	III	G2/(10)	1.25	2.5x1.5	4.5
2	IV	H2/(17)	2.2	3.5x2.5	16.5
2	IV	H2/(18)	2.8	3.5x2.5	11.5
2	V	G2/(18)	2.3	Broken	23.0
2	V	H2/(27)	2.6	3.5x3	13.0
2	VI	G2/(24)	4.2	4.5x4.5	22.0
2	VI	G2/(25)	3.5	3.5x2.5	9.5
3	III	H2/(15)	3.55	2x2.5	
3	VI	H3/(20)	1.4	on 2x2	
3	VI	F3/(28)	1.1	2x1.5	

¹ For classes 1 and 3 thickness is measured at 10 mm. from the tip; for class 2 it is measured just behind the start of the cut which forms the tip.

4) Shell artefacts

Three shell artefacts were found in Horizon VII. All are shells of the marine species Cypraea moneta (Money Cowry). These three whole shells all have a large round hole in the back. Both Dr McMichael and I consider these holes to be humanly made, which means that the shells were sewn onto fabric or strung together for decoration.¹ The existence of trade with the coast some 9000 years ago, and the use of marine shells for decoration documents a very long continuing tradition in the area.

5) Ochre

Ochre, nearly all of it red iron oxide, was found throughout the deposit. It was concentrated in Horizons I-VI, with much less being found below this. The decline is sharp enough to suggest that painting was much less common in this period.

Eighteen pieces, mostly weighing more than 10 gm., show surface traces of rubbing or cutting, probably caused by preparing powder for making paint.

There is no evidence as to the purposes to which most of this paint was put. Table 7.15 sets out the distribution of ochre in the site.

Thirty four stones have some red ochre adhering to them. These stones were found throughout the deposit but were commoner in the upper horizons, so that their distribution conforms to that of the ochre. One stone is

¹ S. and R. Bulmer, 1964, p.56.

Table 7.15 : Ochre

Horizon	Weight in gm.	Gm./cu. metre	No. with rubbing	Weight of pieces with rubbing
I	93.6	54.1	2	13.3
II	115.1	59.9	-	-
III	444.7	127.0	5	222.3
IV	314.1	111.0	4	88.2
V	324.8	70.7	2	21.3
VI	355.8	64.7	4	100.3
VII	35.4	10.1	-	-
VIII	88.6	23.0	1	81.4
IX	40.6	9.5	1	33.3
Total	1812.7	60.1	19	560.1

painted with a design, but all others seem to be by-products of ochre-working.

The stone with a design on it is from Horizon I. It is an oval, flattish river pebble of volcanic rock (6.6 x 3.9 x 2.4 cm.) on which a double pattern has been painted (Fig. 7.13c). The lower design comprises four dark red stripes, each 0.6-1.0 cm. wide, which run from pole to pole. Two stripes are on one face, one is down one side and the other is asymmetrically placed on the other face. Superimposed on this are two pinkish-red crosses, one on each face. The uprights are set in the centre of each face and meet at the ends, while the cross-bars meet to form a circle around the middle of the stone. All the lines are about 1.1 cm. wide.

The rest of the stones may be divided into three classes.

i) Five flat putative knives for cutting ochre. One flake, from Horizon IV, has 0.6-1.0 cm. smears along both sides of an edge (Fig. 7.13b). Scratches running parallel with the edge can be seen in the ochre, showing that the flake was used for cutting. Part of the edge is broken, probably by use. Another small flake, from Horizon III, has narrow smears of ochre on both sides of an edge. The other three flakes have ochre on one side of the edge only, and the smears are only 1-3 mm. wide.

ii) Stones with dots or small patches of ochre, which has an irregular surface. The ochre was probably dry when applied to these stones. A few might have been used for crushing dry ochre to powder. Three interesting pieces are a) a small piece of river pebble with a

straight red line less than 0.5 mm. wide drawn along one face, clearly with a dry crayon (Horizon VI). b) A flake so heavily rubbed with ochre that all ridges are covered and there are patches on most flat surfaces (Horizon V). c) A 3.7 kg. pebble shows an 8 x 2 cm. patch of ochre on one face as if a large piece had been dry-rubbed on it (Horizon V).

iii) Stones with large smooth smears of ochre which seems to have been applied wet. Some of these may have been used as palettes, but in many cases this is impossible since the ochre occurs on corners of the stones. Possibly they were used for mixing wet paint.

The distribution of these artefacts is set out in Table 7.16. Three stones in each of classes ii) and iii) have also been used as implements, but most others in these classes are smooth river pebbles of volcanic rock.

Table 7.16 : Distribution of ochre stones

Horizon	Class				Total	No./cu. metre of deposit
	Design	1	2	3		
I	-	-	-	1	1	0.6
II	1	2	1	1	5	2.6
III	-	1	1	3	5	1.4
IV	-	1	2	3	6	2.1
V	-	-	6	2	8	1.7
VI	-	-	2	2	4	1.0
VII	-	-	-	1	1	0.5
VIII	-	-	-	1	1	0.3
IX	-	-	-	2	2	0.5

6) Obsidian

Four pieces of obsidian were found, which, since it is not available locally, demonstrates trade within the Highlands. Two pieces come from each of Horizons I and II. Unfortunately too little is known about Highlands obsidian to trace these pieces to a source. Two show signs of use.

7) Wax

In Horizon I, 4.5 gm. of a hard black waxy substance was found. This is too soft for stone or glass and shows no signs of minerals under a petrographic microscope.¹ It is possibly old and dried-out plant wax, such as is used today in various craft activities.

5. Flaked Stone1) Waste Material

The 480 excavated spits produced a total of about 250,000² flakes and lumps which showed no traces of secondary working or use. This is more than 99 per cent of the total number of pieces of stone at the site and clearly shows that the site was a workshop throughout the period of occupation.³

1

Inspection by C.A. Key, Dept. of Anthropology, Australian National University.

2

Estimated on the basis of 25 spit bags with a mean of 530 pieces.

3

Compare Mulvaney and Joyce, 1965, Table 1; S. Bulmer, (1966), p.108b.

Most of the material is chert, frequently the dark red-brown type used to make implements.

A size analysis was carried out on six samples, totalling 12,686 waste pieces, selected from top, middle and basal levels (Table 7.17). Many highly significant differences occur both within and between samples.¹ These do not however form any consistent pattern, so that departures from the expected norm occur at random and there is no consistent change in the size of waste material throughout the site.

It may therefore be argued that there was no significant change in flaking technique and size of raw material throughout the occupation and also that the presence of more large or small flakes is due to chance factors like an extra-large core, the condition of the piece of stone used and so on.

The distribution of the waste material may also be used to corroborate the concentrations of stone-working observed in the implement plots. This has been done in two ways - a) by totalling the weight of waste material per unit volume in each horizon and b) by dividing each excavated square metre into units of 20 cm. depth (i.e. standard volume) and weighing the amount of material in each unit. Graphs of the results of method b) applied to square G2-5 are given here (Figs 7.8, 7.9). Weight can be used in each case since it is known that there is no

¹ See Appendix 7.4. χ^2 tests by Dr W. Ewens, ex-Department of Statistics, S.G.S., A.N.U. I am grateful to Dr Ewens for assisting with the interpretation of these results.

Table 7.17 - Waste material - number of pieces

Horizon	Size					Total
	< 1"	1-1"	1-1 1/2"	1 1/2-2"	> 2"	
I	1052	678	86	17	3	1836
I-II	1518	827	111	21	4	2481
III-IV	1692	930	141	19	1	2983
IV	1153	781	128	23	3	2088
VII	1210	684	159	27	8	2088
VIII-IX	655	436	81	19	6	1197
Total	7891	4336	706	126	27	12686

Table 7.18 - Waste material - weight/horizon

Horizon	Total Weight (gw.)	gm/cu. Metre ¹
I	13281	7739
II	18441	9810
III	29321	8350
IV	29963	10600
V	41721	5060
VI	23194	5860
VII	25328	7210
VIII	34380	8910
IX	10312	2420
Total	226041	7310

¹ Calculated to nearest 10 gw.

consistent alteration in the size of waste material. The graphs and tables show that concentrations of material occur within the site, and that these tend to slope towards the front of the shelter, dipping perhaps 50 cm. in a distance of 4 metres.

2) Hammers and Anvils

Twenty six hammers and four anvils were found. The hammers are characterised by battering on the ends or sides of river pebbles, the anvils by battering on a flat surface.

All these tools are made on volcanic rocks, either tuff, basalt, diorite or a variety of porphyry. Since half the tools are on broken pebbles only half are definitely whole. The majority of tools weighs less than 500 gm., with whole hammers weighing 83-1270 gm. One hammer shows some powdered ochre around the area of battering.

Hammers were found throughout the site, but anvils occurred only in the lower horizons.

The distribution of these tools is set out in Table 7.19, while a detailed description of each tool is given in Appendix 7.5.

Table 7.19 : Hammers and Anvils

Square	Horizon									Total
	I	II	III	IV	V	VI	VII	VIII	IX	
F3	-	-	1	-	1	1+2A	-	-	-	3+2A
F4	-	-	-	-	-	-	-	1+1A	-	1+1A
F5	-	-	-	-	1	1	1	1	-	2
F6	-	-	-	-	-	-	-	-	-	2
F7	-	-	-	-	-	-	-	-	-	1
G2	1	-	-	-	-	-	1	-	-	3
G3	1	-	1	1	2	-	1A	3	-	6+1A
G4	-	-	1	1	-	-	-	1	-	2
G5	-	-	2	1	-	-	-	1	-	3
H2	-	-	-	-	-	-	-	-	-	1
H3	-	-	1	-	-	-	1	-	-	2
H4	1	-	-	-	-	-	-	-	-	2
Total	3	-	5	3	4	2+2A	3+1A	6+1A	-	26+4A

3) Trimming Flakes

Trimming flakes occurred throughout the deposit and there is an average of one for every four flaked implements (Table 7.20, p.307). The ratio of implements to trimming flakes varies consistently through the site being high (>4.4) in the lower horizons, dropping sharply in Horizon VI to 2.9 and then climbing to over 4 again in the upper horizons. The generally low numbers of trimming flakes reflects the ready availability of raw material, in contrast to the situation at Batari.

4) Joins

Only nine pairs of flakes or implements which had broken in antiquity were joined together despite - or probably because of - the large amount of stone material. Of the eighteen pieces, fourteen came from the same square and spit, two came from the same square but four spits (24-30 cm.) apart and two came from adjacent squares and with a vertical separation of 55 cm. The last pair came from towards the rear of the shelter (G2, G3) where the earth was softer and this may have assisted migration.

This number is of course too small to use as a basis for generalisation, but it does suggest that some migration has occurred within the deposit and that it would be unwise to analyse material in stratigraphic units smaller than the arbitrary horizons.

Table 7.20 - Trimming Flakes - number.

Horizon	Square												Total	Number of specimens per trimming flake
	P3	P4	P5	P6	P7	G2	G3	G4	G5	H2	H3	H4		
I	6	-	-	-	-	16	-	1	-	4	1	-	28	5.9
II	7	-	-	-	-	15	1	2	-	27	10	-	62	4.2
III	8	-	-	1	-	3	17	11	2	31	10	6	85	4.1
IV	5	-	-	1	-	2	4	7	1	20	11	8	59	4.8
V	7	-	3	7	-	1	3	8	8	19	12	16	84	3.9
VI	10	-	1	11	-	5	11	4	1	6	9	8	66	2.9
VII	8	3	1	-	-	-	11	4	1	-	7	2	37	4.4
VIII	4	2	3	-	-	-	5	3	3	1	18	3	44	4.6
IX	-	1	1	-	-	-	-	-	-	-	2	1	5	9.0
Total													470	4.16

5) Use-polished tools

Twenty seven pieces of stone with gloss along one margin were found, scattered throughout the site (Table 7.21).

Study of these tools does not suggest that their overall shape or size is particularly significant. All whole tools can be held comfortably and none show shaping retouch. Generally they seem to be larger than retouched tools, but the sample is too small to be sure. The majority of these tools is made in dark fine-grain volcanic rocks without inclusions; only four are made on the red and brown chert which is the common material for retouched implements.

The use-polish has been carefully studied with a hand-lens (10x) and binocular microscope. Four different types of polish have been distinguished, based on the position, direction and intensity of gloss and wear striations. These variations may relate entirely to the way the tool was used, but they may also imply that different materials were being treated. The types are:

1. Equal wear on both sides of the edge with all striations running at right angles to the edge. Most striations are short and thick. The polish extends 4-6 mm. back from both sides of the edge and then fades out rapidly (Fig. 7.13a).
2. Similar to 1, but shows a few long deep striations, parallel to the edge. The wear on both sides does not seem to be precisely equal.

Table 7.21 : Tools with Use-polish

Square	Horizon									Total	
	I	II	III	IV	V	VI	VII	VIII	IX		
F3	2	1									3
G2	1	1			1	2			1		2
G3	1		1	1						2	2
G4			1		1						2
G5		2	1	2							5
H2			1	1		1					3
H3	1			1	1				1	1	3
H4											
Total	5	4	3	4	3	3	-	2	3		27
No. as % of total retouched implements	3.1	1.8	0.9	1.5	0.9	1.6	-	1.0	6.2		1.4
No./cu. metre	2.9	2.1	0.9	1.3	0.7	0.8	-	0.5	0.7		0.9

3. The most marked striations occur parallel with the edge and are long and deep. Some short scratches occur at various angles to the edge. The wear is approximately equal on both sides.

4. Very similar to 1, but with nearly all wear on one side of the edge, showing that the tool was moved quite differently.

At least 16 examples of type 1 occur, while the other types are represented by only one each. In addition eight implements have too little wear for them to be classified. Nine of the 16 specimens of type 1 are broken, four of them being flakes struck from use-polished edges. Of the other seven, five may be whole implements.

On two tools, small areas away from the edge show light polishing on slightly projecting parts of the stone (Fig. 7.13a). It seems almost certain that this is due to movements of the hand while the tool was in use. Most of the edges are chipped as well as polished, and two show step-flaking retouch. All edges are straight or slightly concave (indentation index <20). The angles of these edges are acute (Table 7.22).

Some idea of the function of these tools may be deduced by comparison with data in other parts of the world.¹ The very high gloss combined with many shallow striations is good evidence that the material being worked was plastic and not hard.² The equal wear and right

¹ Semenov, 1964, pp.83-129.

² Semenov, 1964, p.115. Compare also use-polish on sago pounders (see Ch. 3).

angled striations of class 1 suggest that the tool was held edge-on and pushed through soft material. In other parts of the world hide or skin-working would be a logical suggestion, but S. Bulmer's reminder¹ that bark cloth and other fibres needed to be prepared is probably more appropriate for the Highlands.

The wear on class 2 tools suggests that some sawing went with this type of use, while class 3 wear was primarily produced by a sawing motion.

Class 4 tools were used entirely with a one-way motion so that only one side of the tool came into contact with the material. The obtuseness of this edge, if found to be normally associated with Class 4 wear, will suggest that a very different purpose was involved, though perhaps the same material was being worked on.

It is hoped that ethnographic and microscopic studies of this use-wear will be pursued more fully later.

Table 7.22 : Angle of edge of use-polish*

Class	Angle (degrees)							Total
	30-9	40-9	50-9	60-9	70-9	80-9	>89	
1	1	-	7	3	4	-	-	15
2	-	-	1	-	-	-	-	1
3	-	-	-	-	1	-	-	1
4	-	-	-	-	-	-	1	1
Total								18

* Not measureable on all tools.

¹

S. Bulmer (1966), p.148.

6) Flaked stone tools (Figs 7.14, 7.16-7.19)

A total of 1,954 stones with secondary retouch or use-wear was excavated from Kafiavana. These implements, as has been outlined earlier, were concentrated in two and possibly three groups in the site. In these levels their density/cu. metre is higher than in other parts of the site. This is obscured to some extent when the site is considered as a whole, due to the large number of artefacts and the lack of clear divisions in the three squares against the back wall of the shelter (F3, G2, H2). The divisions can be seen in the other squares (Tables 7.23, 7.24, p.316).

These tools have been analysed by both methods outlined in Ch. 3. For the standard typology 806 whole tools, utilised pieces and cores have been included. Tools from the three back squares have not been included because of the considerable slope and possible mixing due to increased treadage in the softer soil.

1) Standard typology

Most of the tools are scrapers and their morphology does not alter visibly throughout the deposit. Although there are some with deeply concave edges none of the 'double concave' scrapers with separating ridge of the type seen at Aibura and Batari were found (Table 7.25). Occasional large retouched and utilised flakes occur but these do not seem to form a special type: S. Bulmer notes this at Kiowa also.¹

¹ S. Bulmer (1966), p.88.

The major change which occurs is that retouched tools get consistently larger towards the base of the deposit. This change is clearly a slow one rather than a sudden shift and it shows up clearly when the weights of retouched tools are considered (Table 7.26). Inspection suggests that this change is not restricted to a particular type but occurs within all tool classes.¹ It occurs irrespective of raw material size and it is not inversely related to the amount of retouch.

Among the unretouched but used pieces there is also an increase in size with depth in the deposit, but this is much less marked and may not be significant. There are not many of these pieces.

Three significant changes in the proportion of various tools occur. In Horizons I-II utilised flakes are much more common and the number of retouched tools declines. This replacement of retouched by unretouched tools is similar to that found at Aibura Horizon I (<1000 years).

The second change is the rise in multiplane scrapers (Figs 7.14, 7.16a, 7.17a, 7.19b) in the upper two horizons. Although the numbers are small, this does suggest that some retouched tools were more heavily used in recent times.

The third important feature is the large number of pebble tools (Fig. 7.15) in Horizons VIII-IX. Although tools made on pebbles weighing more than 100 gm. occurred occasionally throughout the site, there were many more in the lowest horizons. All are made on grey non-greasy

¹ See table p.314.

For example, the weight of multiplane scrapers (percentage distribution) is as follows:

Horizon	Weight in gm.											Total No.
	0-4	5-9	10-4	15-9	20-4	25-9	30-4	35-9	40-4	45-9	> 49	
I-II	-	17.6	17.6	17.6	5.9	17.6	11.8	5.9	-	-	5.9	17
III-V	1.4	4.2	11.3	19.7	21.2	8.5	11.3	4.2	5.6	2.8	5.9	71
VI-VII	-	10.3	6.9	17.2	13.8	6.9	-	6.9	6.9	6.9	24.0	29
VIII-IX	-	-	15.4	-	-	23.1	7.7	7.7	7.7	-	38.5	13

chert and volcanic rocks rather than the normal red-brown chert. Some of these tools appear to be cores but others are step-flaked. The presence of these tools in the lowest horizons suggests that a wider range of raw material was used by the earliest inhabitants at the site.

1. Horizons I-II. These have a high percentage of utilised pieces (nearly half of all tools). The retouched tools are not large in size. Multiplane scrapers are rather common.

2. Horizons III-VII. The tools from these horizons form the majority of the implements in the deposit. Their form and size is standard throughout with no very large pieces except for two pebble tools in Horizon V. The percentage of utilised pieces is lower and multiplane tools are less common.

3. Horizons VIII-IX. Many of these tools are larger and more are on cores or chunks, not flakes. Utilised pieces and multiplane scrapers are not common. Twelve whole and more than ten broken pebble tools on coarse grey stone serve to distinguish these horizons. The scrapers are very difficult to classify as the position and amount of retouch is extremely irregular.

Table 7.21. | Impement Distribution

Horizon	Square												Total
	P3	P4	P5	P6	P7	O2	O3	O4	O5	O2	O3	O4	
I	21	-	-	-	-	42	31	12	4	23	20	11	164
II	20	-	-	-	-	37	21	11	4	90	31	4	226
III	73	-	-	-	4	12	47	45	28	79	44	19	351
IV	15	-	-	8	1	15	20	45	32	45	20	32	284
V	25	-	19	82	-	1	13	49	32	37	23	41	323
VI	20	-	4	75	-	3	23	12	3	10	18	7	192
VII	12	11	9	-	-	5	28	16	8	3	47	16	165
VIII	12	22	15	-	-	-	18	41	26	-	33	23	202
IX	2	15	11	-	-	-	-	9	6	-	1	1	45
Total												1954	

Table 7.22. | Impement densitr per sq. metre

Horizon	Square												Total
	O2	O2	P3	O3	O3	P4	O4	O4	P5	O5	P6	P7	
I	100	88	116	129	-	-	63	35	-	25	-	-	54
II	168	260	165	91	120	-	48	15	-	14	-	-	118
III	28	260	242	157	117	-	128	62	-	93	-	9	100
IV	75	150	26	44	100	-	190	166	-	68	27	5	100
V	4	110	70	29	48	-	100	89	23	64	164	-	31
VI	15	40	107	32	44	-	20	15	12	70	162	-	49
VII	31	23	69	103	117	35	26	24	17	16	-	-	47
VIII	-	-	80	33	64	31	85	63	23	90	-	-	32
IX	-	-	10	-	2	37	18	2	12	8	-	-	11

Table 7.23 - Tool types - number

	Horizon								Total
	I	II	III	IV	V	VI	VII	VIII-IX	
1. Total tools	31	61	192	199	259	143	126	223	1204
2. Whole retouched tools	27	15	67	80	115	67	52	74	438
3. 2 as percentage of 1	29.06	24.66	34.96	40.25	44.05	46.84	39.66	32.96	36.25
4. Utilised pieces	42	20	35	29	42	25	19	40	260
5. 4 as percentage of 1	46.15	45.95	18.25	14.65	16.25	17.56	14.25	17.86	19.25
6. Cores	-	1	1	1	7	3	4	8	25
7. Scrapers - total	24	13	66	79	112	67	50	61	473
- side	5	5	23	22	34	26	13	20	148
- end	1	1	10	12	13	6	7	12	64
- double side	2	1	2	6	12	4	7	2	36
- side and end	3	-	10	7	13	7	7	7	54
- double side and end	1	-	2	3	1	3	2	3	19
- diamond	-	1	3	2	1	3	3	1	14
- inverse retouch	-	-	-	2	-	-	-	-	2
- double end	-	-	-	-	-	-	-	1	1
- core-scrapers	-	-	-	-	1	-	-	-	1
8. - multipiece	12	3	16	24	31	16	13	13	120
9. 8 as percentage of 7	30.05	38.25	24.25	30.45	27.45	23.95	25.05	21.25	27.45
10. Bifacial retouch/used	3	-	-	-	1	-	1	1	6
11. Pebble ? core	-	-	-	1	-	-	-	-	1
12. Pebble tool	-	2	17	1	2	-	-	12	18
13. Broken retouched tools	22	18	89	89	100	31	60	109	528
14. 13 as percentage of 1	24.25	29.25	46.45	44.75	38.65	33.75	44.75	48.25	41.25

Table 7.26(a) : Retouched tools - weight (Per cent)

Horizon	Weight (gm)						Number
	0-9	10-9	20-9	30-9	40-9	>50	
I	18.5	37.0	26.0	3.7	3.7	7.2	27
II	13.3	22.2	6.7	26.6	-	20.0	13
III	13.6	24.2	23.2	13.1	6.5	9.1	67
IV	6.2	40.7	23.5	12.3	3.7	13.6	80
V	8.5	21.4	24.0	15.7	13.7	17.1	115
VI	10.1	20.2	26.1	17.4	7.2	15.9	67
VII	3.8	18.9	24.5	9.4	15.1	28.2	53
VIII-IX	2.7	12.7	12.7	16.4	8.2	45.2	74

Table 7.26(b) : Utilised pieces - weight (Per cent)

Horizon	Weight (gm)						Number
	0-9	10-9	20-9	30-9	40-9	>50	
I	71.4	9.5	4.8	7.1	2.4	4.8	42
II	60.6	26.6	7.1	-	-	3.6	20
III	27.1	23.7	2.9	2.9	2.9	11.6	23
IV	28.6	20.7	-	-	10.3	10.3	29
V	27.1	16.7	7.1	4.8	2.4	11.9	42
VI	46.0	26.0	4.0	8.0	4.0	-	25
VII	47.4	21.4	-	-	-	21.0	19
VIII-IX	25.0	10.0	17.5	10.0	2.5	5.0	80

ii) Attribute analysis

An analysis of all pieces of stone showing retouch or use-wear was carried out. Most results are described in Tables 1-31 (Vol. 2). Particular comparisons with other sites are included in the text.

A. Analysis referring to each stone implement as a unit (total 1,954)

1. Type of stone: From Horizons I-VII there is a very consistent use of stone, with just over half being a specific type of red-brown chert, and other greasy chert being used for about $2/3$ of the rest. In the two lowest horizons however, other sorts of stone become much more common (Table 1). This probably relates to the use of 'pebble tools' and the flakes detached from them.

2. Number of planes/implement: In all horizons about $4/5$ of all implements were used in one plane only (Table 2a). There are rather fewer multiplane implements than at Batari, but both industries exhibit a general lack of formal orientation.

3. Number of edges/implement: In the top six horizons about 70 per cent of implements have 1 or 2 edges (Table 2b). Below this, rather more implements have more than 2 edges. Horizon IX is aberrant. In no horizon do more than 10 per cent of implements have more than 4 edges.

4. Weight of implements: The weights of implements increase from the top horizons down, and within the overall pattern three groups may be differentiated - Horizon I where the number of tools weighing less than 10 gm. is high; Horizons II-VII which show a generally

similar pattern with a slight but consistent increase in weight with depth and Horizons VIII-IX where many more tools weigh over 130 gm. and there are also slightly more tools weighing less than 10 gm. than in the levels above (Table 3).

The differences in weights between Horizons I, IV and VIII have been tested statistically. Between HI and HIV $\chi^2 = 27.22$ with $n = 6$, which is significant at the 0.1 per cent level. Most of the variation lies in the 0-9 gm. group. Between HIV and HVIII $\chi^2 = 33.78$ with $n = 5$, significant at the 0.1 per cent level. Most variation is in the >50 gm. group and there is no difference in the 0-9 gm. group.

Implements used on two planes tend to weigh more than 10 gm. more frequently than implements used on one plane. However, most heavier implements were only used on one plane (Tables 4). This picture is similar to that at Batari. Implements with more than 2 edges also tend to weigh more, suggesting that they were not selected for re-use unless they were above a certain size (Tables 5).

5. Edges: A total of 4181 edges was observed on the 1954 stone implements. By horizons the numbers are:

Horizon	Number	Mean edges/implement
I	353	2.15
II	478	2.22
III	717	2.04
IV	580	2.04
V	719	2.21
VI	386	2.01
VII	391	2.07
VIII	482	2.38
IX	75	1.67
Total	4181	2.14

B. The following analyses use the edge as the basic unit of description

1. Whole implements: Under 10 per cent of all edges are on implements which can definitely be called 'whole' in relation to that particular edge, although rather more can be called 'probably whole' (Table 6). With over 2/3 of all edges it is unclear whether the implement is, for that edge, whole or not. Horizon IX is aberrant in having many more 'whole' implements.

There are fewer 'whole' and more 'probably whole' implements than at Batari and also slightly fewer 'not whole' implements.

2. Raw material: Over half the industry is made on stones which have some pebble cortex remaining on them and about one quarter has no cortex (Tables 7). The number with cortex remaining is of course only a minimum indication of the number of tools actually made on river pebbles, but even so it is very high. It not only confirms that the Fayantina River was probably the source of raw material throughout the period of occupation, but also suggests that chert was used lavishly and without continuous re-working. The contrast with Batari in this respect is quite striking.

3. Size and shape of implements:

(i) Weight. Tables 8(a)-(c) show that most implements weigh less than 30 gm. It seems 'probably whole' tools generally weigh more than 'whole' tools, though there are very few of the latter. There are fewer heavy 'not whole' implements, which tends to confirm the correctness of this diagnosis: this division is not, however, as clear as it was at Batari.

(ii) Shape. Tables 9 and 10 express the shapes of implements in terms of Length/Breadth and Breadth/Thickness indices. The Kafiavana implements are clearly square rather than blade-like, but tend to be flat rather than chunky, with B/Th. usually being greater than 2.

Both indices remain fairly stable throughout the history of the site.

The industry at Kafiavana is consistently less chunky than that at Batari, which may relate to less concentrated use of the material and to such factors as fewer multiplane tools. The Kafiavana industry is also slightly more square than that from Batari.

4. Flakes and cores: Around two-thirds of the industry is made on flakes while a third or less is made on cores and lumps (Table 11). The industry is therefore primarily made on flakes, although the same proviso as at Batari must be applied.

C. Descriptive attributes of edges

1. Whole/not whole: Between 40 per cent and 50 per cent of all edges are 'whole' or 'probably whole' and this figure is very consistent throughout the site, except for Horizon IX (Table 12). There is no changing relationship between 'whole' and 'probably whole' as was observed at Batari. There is also a contrast with Batari in that some 20 per cent fewer edges can be classified in these ways, while rather fewer edges are broken at Kafiavana and more have been classed as indeterminate. This may imply that implements were used less fully at Kafiavana.

2. Base type: Tables 13(a)-(b)¹ show that a wide range of surfaces was used as bases, although about half the bases are formed of positive bulbar surfaces. The increase in pebble cortex bases in Horizons VIII-IX clearly relates to the presence of large 'pebble tools', while the increased percentage of 'not applicable' in Horizons I-II refers to the greater use of utilised flakes. Other sorts of base are used in small proportions throughout the site, and the general similarities with Batari are marked.

3. Preparatory flaking: About half the preparatory flaking consists of removal of one or more large flakes struck from the base (Table 14). Rather over one quarter of the edges are not prepared and this is a slightly higher percentage than at Batari. The rise in the 'not applicable' category in Horizons I-II relates to the increase in utilised edges in these levels. Otherwise the proportions are very similar throughout the site.

4. Shape of edge: Between 40 per cent and 65 per cent of whole edges are concave, while two-thirds or more of 'probably whole' edges are concave (Table 15(a)-(b)). An inverse relationship between 'whole' and 'probably whole' is apparent among convex edges and to a slight extent among straight edges. These relationships are dissimilar to those at Batari, but the reasons for this are not clear.

There is no change in the proportions of each shape throughout the horizons at Kafivana.

¹ Table 13(b) relates base types to implements rather than edges.

Tables 16(a)-(c) show that straight and concave edges tend to be about the same length (6-15 mm.), while convex edges are rather longer (11-20 mm.).

It is very noticeable that straight edges at Kafiavana are a good deal longer than those at Batari, with under 10 per cent being less than 5 mm. long, a decrease of more than 20 per cent. The increase in length of concave edges is much less marked, being only about 10 per cent. The numbers of convex edges at Batari are too small to allow for comparison.

The indentation index varies slightly but inconsistently through the site, while the projection index, based on much smaller numbers, shows more marked swings (Tables 17, 18). Convex edges diverge less from a straight line than do concave.

Concave edges at Kafiavana are slightly less concave than those at Batari, which clearly suggests less retouching at Kafiavana due to greater availability of raw material. Convex edges appear to be much the same shape at both sites.

5. Retouch: Nearly all retouch is step-flaking. Just under two-thirds of all edges are step-flaked, and most other edges are not retouched at all (Table 19). Horizons I and IX have fewer step-flaked edges than the others.

Most step-flaking is found on concave edges and very little on convex edges (Tables 25). Edges without retouch are frequently straight. Fourteen edges in the site incorporate two types of retouch. There is less heavy step-flaking at Kafiavana than at Batari.

Nearly all step-flaked edges are on acute angles with the mode being at 60-79° (Tables 20). As at Batari other sorts of unifacial flaking occur on rather more acute edges (Table 20(c)). Very few angles are obtuse. There is a clear trend towards more acute angled step-flaked edges at the top of the site.

6. Use-wear: Less than half the edges show use-wear of the 'chattering' type while only 10 per cent are 'utilised' (Table 21). The rest show no traces of use-wear. The number of 'utilised' edges increases in Horizons I, II and IX, but the percentage of 'chattering' does not decrease. There is generally more 'utilisation' at Kafiavana than at Batari.

Over half the 'chattering' at Kafiavana is concave, though well under half of 'utilisation' is this shape. One-third to one-half of both types of use-wear is straight (Tables 22). There is generally more straight use-wear in the middle levels of the site than at the top and base.

In general, the percentage of each shape of 'utilised' edge is about the same at Batari and Kafiavana but there is about 20 per cent more concave 'chattering' at Kafiavana than at Batari. This, considered together with the lower amount of 'chattering' at Kafiavana, may suggest that some regional variations in certain mechanical activities were present throughout the history of each site.

The normal length of use-wear is under 10 mm. for 'chattering' but 6-20 mm. for 'utilisation'. There is little variation in the length of either throughout the site (Table 23).

'Chattering' at Kafiavana is considerably longer than at Batari, where half of it is less than 5 mm. long. 'Utilisation', on the other hand, tends to be about the same length at the two sites.

Where use-wear is concave the two main types are distinct in terms of the indentation index, with 'utilisation' being less indented than 'chattering' (Tables 24). The index for each type is very similar throughout the site and closely parallels that found at Batari.

Use-wear is nearly all on acute angled edges. The mode for 'chattering' is within the range 60-89°, while the mode for 'utilisation' is 40-49°. There is a tendency for 'chattering' to become steeper in the lower horizons, but the same tendency is not apparent with 'utilisation' (Tables 26).

There is a definite suggestion that 'chattered' edges at Kafiavana are steeper and 'utilised' edges are rather more acute than comparable edges from Batari.

D. Correlations between attributes

1. There is a clear correlation between 'chattering' and step-flaking retouch. Only about half of all 'chattering' is found on step-flaked edges (Table 27(a)), but all step-flaked edges with use-wear are 'chattered' (Tables 28). While two-thirds of all use-wear on unretouched edges is 'chattering' (Table 28(c)), there is a very high correlation between 'utilisation' and unretouched edges (Table 27(b)). This picture is similar to that found in Batari.

2. Unretouched edges tend to occur on thinner implements than those which are step-flaked (Tables 29). It is especially noticeable that very few step-flaked edges are on implements less than 5 mm. thick, which may relate to the mechanics of step-flaking.

3. It also seems that implements with unretouched edges are less chunky and flatter (i.e. greater B/Th. index) than those with step-flaking (Tables 30).

4. There is no clear relation between the size of the implement and the angle of its retouch, though this may be due to the small sample sizes (Tables 31).

E. Summary

It is clear that although there are changes in the industry over time, nearly all of them are only slight and may easily be overlooked.

Basically the data given in this analysis reflect the underlying stability of the industry, while allowing the changes already seen in the standard typology to be expressed more fully.

One feature which only this analysis suggests is the marked divergence of Horizon IX from the norm. In the standard typology this shows up only in relation to pebble tools (Table 7.25). The differences in attributes which distinguish this Horizon, however, cannot all be related to these tools. The importance of pebble tools and their by-products in Horizon IX is shown by stone type, weight and the use of pebble cortex as a base (Tables 1, 3, 13). But, where sufficient numbers allow comparisons to be made, the following differences emerge:

- Higher percentages of whole implements and core-lumps (Tables 6,11).
- More whole edges with less preparatory flaking on them and perhaps more convex edges (Tables 12, 14, 15(a)).
- Less step-flaking, and the angle of the step-flaked edges is less than in other horizons (Tables 19, 20(a)).
- More 'utilisation' in this horizon (Table 21). There is more concave 'chattering' and it tends to be longer (Tables 22(a), 23(a)); 'chattering' occurs more frequently on unretouched edges (Table 28(a)).

Two sorts of variation seem to be involved. One suggests that utilised flake types play a bigger part than is shown in the standard typology - lack of retouch (Table 19), more whole convex edges (Table 15(a)), 'utilisation' (Table 21).

But there are some differences which are clearly not related to this - the slightly higher percentage of core-lumps (Table 11), the more acute angles associated with step-flaking (Table 20(a)) and 'chattering' (Table 27(a)), more concave and longer 'chattering' (Tables 22(a), 23(a)) and the rather higher proportion of 'chattering' on unretouched edges (Table 28(a)). Taken as a whole it is difficult to relate these differences to any one cause. They suggest that tools may have been used a little differently, but whether this can be related only to the presence of pebble tools, or to other differences in the

industry is not clear. This will only be tested by making a comparative study of flaked tools from sites where pebble tools were also regularly produced.

6. Conclusion

Humans first occupied Kafiavana about 11,000 years ago. These people possessed ground stone axes and hunted wild animals. They flaked large stone 'scrapers' and pebble tools and prepared ochre for painting.

The earliest use of the shelter was possibly sporadic, but for about 6,500 years (ca. 11,000-4,500 B.P.) the site was intensively occupied. Fires were lit and much chert was carried up from the Fayantina River for knapping into 'scrapers', a few axes, and pebble tools. In the period 9,500-8,000 B.P. the fireplaces were often made at the eastern end of the shelter, but this area was used for stone working both before and after this. Small numbers of a range of wild animals - mammals from forests and grasslands, birds, reptiles and fish - were brought to the site and eaten. Pig bones occurred from about 6,000 years ago, but whether pigs were kept as domestic animals in this area we do not know.

The stone and bone tool-kit of these people changed to some extent after the earliest occupation. Pebble tools were largely discarded, while many smaller flaked tools were made. The flaked tools changed in some ways, but the techniques of making them remained much the same. Bone tools were made, and later deposited at the back of the site. Human bones were occasionally discarded. People continued to grind axes from local stones, and

ochre was used for painting. From time to time a few shells came along the trade routes from the coast: they were probably always valuable objects. It is difficult to say what economic activities were carried on during this occupation: we can only assume that plant-food was gathered and prepared, and a range of craft activities was pursued. According to Professor Schmid the climate was drier than at present in the early-middle part of this phase.

About 4,500 years ago the site was probably largely abandoned for some 2,000 years or more for fewer tools were found and the humus content of the soil increased. Also, above this level the flaked tools are similar to those made within the last 1,000 years at Aibura, with a very high percentage of utilised flakes and a marked decline in the size of tools.

Along with the variations in flaked tools, axes in this upper level tended to be less well ground and were discarded at the front of the site. Bone tools were less frequently made but more marine shell came along the trade routes. Someone painted a design on a river pebble. The diet also appears to have changed, with pig being more often eaten, especially in the most recent period. This occupation continued until very recent times as is shown by the presence of wooden stakes and fibre arrow bindings. Whether the recent variations in the surviving stone tool-kit indicate that rather different activities were being carried on compared to the earlier period is not known, but it is possible especially since horticulture was probably being practised at this time. It may be suggested that the occupation of Kafiavana in recent times was more sporadic.

The long sequence at Kafiavana has a basic similarity with that at Kiowa, 20 miles away to the northwest. In both sites the main occupation occurs from ca. 10,000-4,000 B.P. Wild fauna predominates but pigs are found in the later part. Dogs do not occur. Trade routes with the coast are open. But there are some striking differences also. At Kafiavana ground stone axes were present at least 9,500 years ago, and were made throughout the occupation; they show no major formal alteration and most are lenticular in cross-section. Pebble tools were found only at the earliest levels in Kafiavana and their manufacture then ceased, but they were made all through the Kiowa occupation. Waisted blades do not occur at all at Kafiavana, although are present from about 6,000 B.P. at Kiowa. There are also other minor differences.

It is not yet certain whether these differences are real ones, pointing to the presence of the Chimbu/Asaro cultural divide in prehistoric times, or whether they are the unreal product of small-scale sampling of only two sites. I am inclined to suspect that while sampling errors may be largely responsible for the absence of ground axes before 6,000 B.P. at Kiowa, a valid cultural division may be indicated by the relative absence of pebble tools and possibly waisted blades east of Chuave. More samples are needed to check these and other generalisations about the prehistory of this area.

CHAPTER 8

EXCAVATIONS AT NIOBE, NEAR CHUAVE1. Introduction

Niobe is a long rockshelter on the eastern backslope of Mt Elimbari, about 3 miles south southwest of Chuave between Kibogu and Leiya villages¹ ($6^{\circ}07'S$, $145^{\circ}10'E$). It is about 2 miles south of the Kiowa site excavated by S. Bulmer,² and lies at an altitude of about 5,400 ft MSL.

The Elimbari range is composed of limestone.³ The backslope is steep with many caves and overhangs, while sinkholes are common in the valleys below. The country round the shelter is heavily gardened, with secondary bush on the steeper slopes. The area is well populated.

Niobe shelter is formed by an overhang and is the minor entrance to a major cave system (Fig. 8.1). The actual sheltered area visible is some 18 metres long and 4 metres wide, and is aligned in a north-northwesterly direction. The greatest breadth of the shelter is about 6 metres where the overhang meets the cave entrance. A foot-track runs along the outer side of the shelter, under cover (Plate 8-1). When it rains the shelter is often

¹ Salisbury, 1962, p.8.

² S. Bulmer, n.d., 1964a, (1966).

³ Rickwood, 1955, Plate 1.

used and work was hampered by men sheltering from the rain and by interested spectators.

Human occupation is indicated by present use, rock-paintings and the presence of worked stone on the floor.

Discovery and excavation

The site was recognised as such by Mrs Bulmer in 1960¹ and was independently re-located by the writer and J.D. Cole. It was excavated in October 1964.²

Initially it proved difficult to get permission to excavate the site. A 2 x 1.5 metre test trench³ was therefore dug rapidly on the south side of the cave entrance. When this proved productive month-long negotiations were made to secure permission to excavate further. When it appeared that the area near the cave entrance had been disturbed it was not possible to work in other areas.

The excavation methods were similar to those used at other sites and a total of 9 sq. metres was excavated to a maximum depth of 1.4 metres.⁴

The major excavation consisted of a trench 5 x 1 metres (A3-A7) extending from outside the dripline (A7) to a point at the cave entrance where the headroom was about 50 cm. (A3). This trench was dug along the north wall of the test trench. A further four square metres in the form

¹ Bulmer, n.d., p.27, Site 73.

² A preliminary report is given in White, 1965a, pp.48-54.

³ Reference number No64.

⁴ Reference number 2/No64.

of two 2 sq. metre extensions to the outer part of this trench were also excavated. These cuttings all ran across the broad dripline (Fig. 8.1).

Stratigraphy (Fig. 8.2)

Visible layers were scarcely apparent in the whole depth of soil excavated in the front part of the site, though slight changes in colour and texture could be seen which appear to be related to the dripline and other natural phenomena rather than human activity. The soil was a uniform dark red-brown in colour. It became more clayey under and in front of the dripline. It contained many small blocks of limestone from the roof, and these were concentrated above about 75 cm. below ground surface. At the base of the excavation two very large, heavily weathered limestone boulders occurred. In this area the site was extremely rich in stone artefacts and bone material.

Towards the back of the shelter large blocks of the deposit were heavily concreted with lime. Much of this concreted material was capped by slabs (4-10 cm. thick) of sterile flowstone, which lay 20-30 cm. below ground surface. The slabs sloped downwards towards the dripline and ended abruptly in A6 and B6 about 50 cm. inside the inside edge of the dripline. They ended about two metres from their highest point, which lay in A4. Although clearly formed in situ as a single block, the upper part of this concreted material has been cracked into several pieces. Cultural material in a soft dry matrix was found in the fissures between and slightly underneath the edges of the blocks to a depth of about 1 metre below the ground

surface. The concreted soil contained large amounts of bone, but facilities were not available to extract this (Plate 8-2).

Division of the material

The deposit has been divided into two arbitrary horizons - upper and lower - for the purposes of analysis. This rather coarse division is used because there is evidence of considerable natural disturbance. This is as follows:

- i) The concreted soil, capped by flowstone, is cracked and the interstices are filled with cultural material. This cracking may well have disturbed the surrounding soil and artefact distribution within it.
- ii) The scattered position of five fragments of the same ground axe (Fig. 8.6). Three fragments were found near the surface - the butt in A3, a large section of body near the A4/A5 boundary¹ and a small chip in B6. The other two fragments were found 62 and 69 cm. below ground surface, both near the same point on the B7/A7 boundary (Figs 8.2, 8.3).

In this situation it seems unwise to work in narrow divisions. The upper horizon therefore includes all material above the flowstone, in the cracks between it, and in the top 70-80 cm.² in front of it. Because of the

¹ This piece was picked out during a cleaning of the section in 1965.

² The slight variations are due to the difficulties of matching spits exactly. This division was made in order to include all fragments of the dispersed axe: it was later found to include all ground axe fragments.

flowstone and large boulders it is not possible to calculate with any accuracy the volume of deposit removed in each horizon. I estimate that each horizon contains about 3.5 cu. metres of deposit.

For certain analytical purposes square Z7, which appears to be less disturbed than the others and which is also deep, was divided into four roughly equal units.¹ Each unit contains approximately 0.35 cu. metres, and is referred to by the spit numbers. The top two units and the top third of the next unit are in the top horizon, the rest being in the lower horizon.

Carbon dates

Carbon samples from this site have not been submitted for dating because of the problems associated with the disturbed stratigraphy.

2. Fauna and Flora

A very large amount of fauna was excavated, but there was not enough time to make a detailed analysis of it. The mandibles, maxillae and teeth have been extracted, and basic sorting and counting completed.² None of the post-cranial bone has been identified and all statements about fauna are based on cranial remains only. All the bone is rather broken, and the teeth have been evulsed from most jaws.

¹ Spits 1-3, 4-8, 9-13, 14-20.

² Nearly all this was done by Research Assistant Mrs D. Gregory, whose patience and help is gratefully acknowledged.

1) Domestic animals

Pig (Sus scrofa Linnaeus) was found in the top 20 cm. only. All fragments are likely to represent domestic animals.

2) Wild animals

The following animals have been identified:

Macropodidae	: <u>Thylogale bruijini</u> (Schreber)	Scrub wallaby
Phalangeridae	: <u>Phalanger spp.</u>	Cuscus
	sub-genus <u>Pseudocheirops spp.</u>	Large ring-tailed phalanger
	sub-genus <u>Pseudocheirus spp.</u>	Small ring-tailed phalanger
	: <u>Dactylopsila spp.</u> or <u>Dactylonax sp.</u>	Striped phalanger
Dasyuridae	: <u>Satanellus albopunctatus</u> (Schlegel)	Native 'cat'
	: close to <u>Antechinus</u>	Broad-footed marsupial 'mouse'
Peramelidae	: <u>Peroryctes sp.</u> or <u>Echymipera sp.</u>	Bandicoot
Megachiroptera:	sub-family Pteropodinae	Flying-fox
Muridae	: Cf. <u>Hyomys sp.</u>	Giant rat
	: Cf. <u>Uromys sp.</u>	Giant naked-tailed rat

Numbers of animals have been calculated on the basis of mandibles, since these form the largest component of the cranial material. On a within-horizon basis at least 926 animals occur within the excavation. If each square is considered separately, the number rises to 967. This

is an approximate figure only and does not take any account of the large number of mandible fragments found in the site. I estimate that the identification of these would add several hundred animals to the number.

The number of mandibular fragments is:

	Horizon	
	Upper	Lower
? Macropod	235	60
? Cuscus	494	219
Unidentifiable - large animal (e.g. cuscus)	453	329
- smaller animal	149	159

Table 8.1 sets out the data on animal remains, on a within-horizon basis. It shows that cuscus and flying fox make up the majority of the fauna. The importance of bats no doubt reflects the presence of many nearby caves in which these creatures roost. The importance of cuscus probably shows that in prehistoric times areas of primary or secondary forest persisted in this topographically broken area.

An attempt has been made to see whether the proportion of animals changes over time. The minimum number of animals within each unit of square Z7 was calculated from the mandibles. Table 8.2 sets out the results.

Table 8.1 : Niobe - minimum number of animals

	Horizon		Total
	Upper	Lower	
Pig	2	-	2
Macropods - adult	82	28	110
- juvenile	27	4	31
Phalanger - adult	235	107	342
<u>Pseudocheirops</u>	49	17	66
<u>Pseudocheirus</u>	18	4	22
<u>Dactylopsila/Dactylonax</u>	7	4	11
<u>Satanellus albopunctatus</u>	1	2	3
Cf. <u>Antechinus</u>	1	-	1
Peramelidae ¹	23	14	37
Pteropodinae ²	198	94	292
Large murids	7	1	8
Fish	-	1	1
Total	650	276	926

1. Calculated by dividing total number of fragments by 4.) These divisors
 2. Calculated by dividing total number of fragments by 5.) were selected
 after handling the
 material and
 assessing the
 amount of breakage
 involved.

Table 8.2 : Square Z7 - minimum number of animals

	Spits							
	1-3		4-8		9-13		14-20	
	No.	%	No.	%	No.	%	No.	%
Macropods - adult	1	9.1	4	16.7	13	12.4	10	10.2
- juvenile	2	18.2	-	-	-	-	-	-
<u>Phalanger</u>	7	63.6	7	29.2	42	40.0	48	48.5
<u>Pseudocheirops</u>	-	-	1	4.2	3	2.9	6	6.1
<u>Pseudocheirus</u>	-	-	1	4.2	2	1.9	-	-
<u>Dactylopsila/Dactylonax</u>	-	-	-	-	-	-	2	2.0
<u>Satanellus</u>	-	-	-	-	-	-	1	1.0
Peramelidae ¹	-	-	1	4.2	7	6.7	4	4.0
Pteropodinae ²	1	9.1	9	37.5	36	34.3	27	27.3
<u>Hyomys</u>	-	-	1	4.2	2	1.9	-	-
Fish	-	-	-	-	-	-	1	1.0
Total	11		24		105		99	
Number animals/cu. metre	3.9		8.4		36.8		34.7	

¹ Fragments divided by 4.

² Fragments divided by 5.

This table suggests that the absolute number of animals and the relative number of species in this square declined in more recent times,¹ but there is no evidence of any environmental change through time. The flying fox bones consist mostly of ulnas, radii² and femurs;³ practically no other bat bones were recognised. In nearly all cases the proximal ends were intact but the distal ends of the bones were missing. I think that this possibly reflects certain cooking and eating practices. The general absence of pelves is rather surprising but these may be more broken up than relatively smooth shafts and therefore not recognised.

It is interesting to note that Kiowa, 2 miles away, also produced 'an enormous amount'⁴ of fauna. At Kiowa, dog has been identified only at the surface and pig from levels 2 and 3. Among the wild animals which make up the bulk of the fauna, Dendrolagus, Phalanger, Pseudocheirus and Dobsonia are common.⁵ This is different from Niobe where domestic animals are apparently recent, and the common macropod is Thylogale bruijini. However, in the absence of any analysis of the Kiowa faunal material, either by excavated levels or in terms of the number of animals involved, comparisons are difficult to make. Differences may also arise from a disparity in ages between the two sites.

¹ It is likely that more recent occupation was further inside the shelter.

² Identified by Mr R.J. Scarlett.

³ Identified by Dr J.C. Yaldwyn.

⁴ S. Bulmer (1966), p.94.

⁵ Ibid.

3) Birds

All bones provisionally identified as bird were submitted to Dr J. Yaldwyn. He reports that only 12 fragments were bird remains, none of them being domestic fowl. Included among the fragments are two pelvises and two distinctive metatarsals from A6/(9) and A3/(3).

In addition, all bones from eight spits were carefully scanned for bird remains by Mr R.J. Scarlett. Seven of the spits were in Z7¹ and the other was A4/(3): they were spread through the depth of the site. Three spits² from the lower unit in Z7 produced two possible tibio-tarsus bones of small birds and one ?cassowary claw. The only other bird bone was a medium sized shaft, probably ulna, in A4/(3).

The virtual absence of cassowary in these samples is surprising when Kiowa, 2 miles away, contains 'large quantities of Cassowary'.³ If there is in fact a difference, which cannot yet be proven, it is difficult to point to a reason for it. It might be that Niobe post-dates Kiowa and cassowaries were rarer then, or it might be that the sites were put to different uses, though it is hard to think what they might have been. This problem can only be answered when more detailed faunal analyses from Kiowa are available.

¹ Spits 4, 6, 9, 10, 14, 18, 19.

² Spits 14, 18, 19.

³ S. Bulmer (1966), p.94.

Small pieces of cassowary eggshell occurred throughout the site. In the upper horizon there were 191.0 gm. while there were 50.9 gm. in the lower horizon. This means that at least 4 eggs are represented, and probably many more were in fact present.

Other eggshell was also common throughout the site. It has not been identified, but probably belongs to wild birds such as brush turkey. In the upper horizon there was 15.4 gm., much of it from the middle and lower parts of square A5. In the lower part of the site there were 3.2 gm. of shell.

4) Mollusca

Three fragments of marine shell have been identified by Dr McMichael.¹ All came from the upper horizon. Two are Yellow Olive shells (Oliva carneola Gmelin) and one is a Cowry, probably the Ringed Money Cowry (Cypraea annulus Linn.).

All other shells are unidentifiable freshwater mussels or unidentifiable bivalves. Only two fragments, both FWM, occurred in the lower horizon.

There were also very large numbers of snail shells. Most are broken and none show signs of use as tools. Many of them probably occurred naturally in the site. In the upper horizon 276 pieces (55.4 gm.)² must represent at

¹
In litt. 11/2/65.

²
Some of this is concreted and is therefore overweight.

least 20 snails but in the lower horizon 21 pieces (1.4 gm.) show that many fewer animals were present.

5) Reptiles

Two fragments of Agamid lizard dentary have been identified by Dr Barwick. They came from Z6/(7) and Z6/(10) and may belong to the same animal. The other five reptile fragments are of snakes: one tip of a dentary or maxilla (A4/(9)) comes from a member of the sub-family Pythoninae, but the other four fragments, all from Z7/(15), are not further identifiable.

6) Fish

A few fragments of fishbone were found. Dr F. Talbot¹ considers that they probably come from freshwater species.

7) Human

Nine pieces of human bone were found scattered throughout the site. Most were towards the back of the site and all were in the top horizon. They have been identified by Professor N.W.G. Macintosh² who points out that it is difficult to identify single teeth and therefore some of the identifications could be challenged.

A3/(2): i) Left central upper Incisor. The incomplete root suggests that this tooth is from a young

¹ Curator of Fishes, Australian Museum, Sydney.

² Challis Professor of Anatomy, University of Sydney, whose assistance is appreciated.

person. ii) PM² left. The crown is chipped off and the dentine worn. An old person. iii) PM¹ left.

A3/(3): Right central upper incisor. Very worn. An extremely thick tooth, rather unusual in this respect.

A4/(2): Right mandible with some unusual features. Clearly not a juvenile, but may have suffered some periodontal disease. Evulsion of a tooth occurred pre-mortem and there are perhaps traces of an abscess.

A4/(9): i) Incisor, probably lateral. ii) PM₁, lower. The tooth is not erupted suggesting that it came from a child about 8 years old.

A5/(7): Left, lower, lateral incisor. Some traces of periodontal disease.

B7/(1): Proximal and middle phalanges of the second metatarsal of the left foot.

Z7/(6): M₁, deciduous, left. From a child.

At a minimum two people are represented by these bones.

8) Vegetable Matter

Most of the vegetable matter was heavily carbonised and cannot be identified. Dr R. Muncey¹ identifies a Palmaceae from the upper horizon and Mr R. Pullen identifies the stone of a Sapotaceae, probably Planchonella, from the lower part of the same horizon. Planchonella is a member of the gutta-percha family, and

¹ Division of Forest Products, C.S.I.R.O., in litt., 6/9/66.

fruits of other members of this family are eaten elsewhere in the Pacific, while the seeds are regarded as having medicinal properties in the Philippine Islands.¹ There is however no previous record of members of this family being used in the Highlands, but Planchonella is common at Omkombogo, only 16 miles away (Ch. 2).

3. Artefacts

1) Modern

Several ~~post~~ European artefacts were found. They include (i) a blue bead (diam. 2 mm.). This was found in A6/(4), 20-30 cm. below the surface. Although this very small bead probably moved easily in the deposit, its presence at this depth is perhaps a further indication of some disturbance; (ii) some rubber tubing, part of a glass thermometer and a rusty nail were all found within the top 10 cms.

2) Axe-adze

All axe-adzes and fragments were found in the upper horizon of the site, mostly within the top half of this unit. A total of 49 pieces were found. These comprise 4 whole axes and 40 fragments together with 5 pieces of very thin rectangular blades, of a type unlike other axe-adzes.

¹

I am grateful to Mr Pullen for information about the use of plants outside New Guinea.

i) Whole axe-adzes:

D4.A3/(1)¹ (Fig. 8.5c). Flaked and well ground axe with biconvex faces and flat parallel sides. The cutting edge is asymmetrically bevelled and worn asymmetrically when viewed from a face; viewed end on, it is straight and set straight in relation to the body, forming a sharp angle with the sides. The maximum width is at the midpoint.

12.A5/(4). Small axe, slightly curved when viewed from the side. It is ground all over, and lenticular-sectioned with sharp sides. The sides are biconvex, with maximum width at the middle. The cutting edge is straight but set slightly asymmetrically to the body; it is asymmetrical in plan.

D7.A3/(4). This wholly flaked axe is of oval shape and lenticular cross-section, with a squared butt and cutting edge. The maximum width is at the middle. The cutting edge is symmetrical from all aspects, and is not highly curved.

358 etc.² (Fig. 8.6). Ground all over the body, this is a larger axe of planilateral cross-section with convex faces and flat sides. The butt is flaked to a point. The cutting edge is heavily used and broken, but it was clearly flaked and not ground. Considerable use-polish occurs on one side of the cutting edge. Maximum thickness is found where the cutting edge meets the sides.

¹ Catalogue number.square/(spit).

² This is the axe referred to on p.335 above.

Table 8.3 : Axe-adze measurements (cm.)

Reference	Length	Breadth	Thickness
D4.A3/(1)	8.0	3.4	1.5
12.A5/(4)	6.2	3.1	0.9
D7.A3/(4)	7.1	3.0	1.2
358 etc.	11.9	5.7	2.1

ii) Cutting edge fragments (2). One is a symmetrical bevel from a lenticular sectioned flaked axe with sharp sides. The other is a piece of curved, asymmetrical bevel.

iii) Butt fragments (3). One is squared with diverging sides, from a largely unground, lenticular-sectioned, flaked axe. The second is also squared, from a very broad, lenticular, mostly ground, axe. The third exhibits one flat side and one sharp side, as well as a wholly flaked squared butt. This piece may show that some blades were sawn into shape prior to flaking.

iv) Sides (4). All four pieces are sharp fragments of sides which show the characteristic axe style flaking. All seem to be from lenticular axes.

v) Angled chips (8). Four of these clearly come from square-sided axes, having two ground planes set at 90-100°. One is very sharp (40°) and may be from a blade. The other three may be from lenticular axes but this is not clear.

vi) Chips (22). These show grinding in one plane only.

Some of the stone from which axes are made has been examined by Mr J.M.A. Chappell.¹ He reports that axes D4.A3/(1) and 358 etc. are hornfels of the type known locally as 'gaima' from the Kafetu quarry on the Daulo Pass, some 9 miles northeast of Niobe. One butt fragment is 'besaiya' hornfels from the same quarry. Chappell calls one small chip of bright green stone amphibolitic ?actinolite. This is known to occur in the Schrader Ranges, but there are possibly outcrops near Bundi and in the upper Chimbu valley between Gogme and Gembogl. Other stones are amphibolitic schist, hornblende-hornfels and slaty hornfels, all probably of local origin.

vii) Roughout (1). This seems to be a broken piece of axe-roughout, with the characteristic bifacial flaking of axes.

viii) Thin rectangular blades. The most complete of these blades is 10.4 cms long, 5.8 cms wide and a maximum of 1 cm. thick (Fig. 8.5a). It is ground all over, the sides are parallel and the straight cutting edge is set at right angles to them. The cross-section is very flat and lenticular with very sharp sides. Two other fragments (Fig. 8.5b) also have the same curious cross-section which distinguishes these blades from other very flat thin blades commonly made for the Western Highlands ceremonial use.²

¹ Dept. of Geography, S.G.S., A.N.U. See Chappell, 1966.

² S. Bulmer, 1964a, pp.249-53; L.G. Vial, 'Stone Axes of Mt. Hagen, New Guinea', Oceania, XI, 1940, pp.158-63.

Chappell says that the slaty material of which these implements are made would tend to split flat and that this may account for their thinness.¹

I suggested earlier² that in view of their shape and the fact that all these blades were found within 50 cms of the surface, they might be skeuomorphs on European artefacts. I now find it difficult to envisage what they might be copies of, and it is perhaps more useful to think of them as some kind of local variant of ceremonial axes. I have been unable to locate similar specimens in the literature or museum collections.

3) Axe grinding stones

Three pieces of abrasive rock with smoothly ground, slightly concave faces were found in the top 20 cms. In many respects they resemble unbroken axe-grinding stones, which were excavated by Lampert near Mt Hagen.³ Their presence at Niobe suggests that axes were re-sharpened at the site.

4) Waisted blade

Two waisted blades were found in the lower horizon. One (224.A6/(9), Fig. 8.5d) is shouldered rather than waisted, with the shoulder flaked and the blade ground more on one side than the other.

¹ Chappell, pers. comm.

² White, 1965b, p.52.

³ Lampert (1966), p.7.

The other blade (No 6) is clearly waisted but is broken just above the waist. It has been very heavily water-rolled subsequent to its manufacture.

The measurements given (in cms) are taken as referred to in Chapter 3.

Table 8.4 : Waisted blades - measurements

	Reference	
	224.A6/(9)	No 6
l ₁	7.1	-
l ₂	1.3	-
l ₃	0.6	-
l ₄	4.9	6.8
Br ₁	5.3	6.3
Br ₂	2.9	-
Br ₃	2.8	4.6
Th ₁	1.1	2.2
Th ₂	1.4	-
Th ₃	1.9	2.1

The implements seem to be comparable in size to those found by Bulmer at Kiowa.¹

¹ S. Bulmer, 1964a, p.262.

5) Mortar

One fragment of mortar was excavated in A3/(4), 37 cms below the surface in the upper horizon (Fig. 8.7). It is a wedge-shaped section of a plain stone dish. Both inner and outer surfaces form a smooth curve and there is no sign of a flattened base. The rim was apparently circular, with a radius of 9.1 cms. The height (measured outside) is about 5.2 cms. The thickness of the stone ranges from 1.25 to 1.5 cms. Mr J. Chappell, who thin-sectioned the specimen, says the material is a hornblende andesite, and he tentatively attributes its location to Banz or further west.¹ Banz is about 40 miles west of Niobe.

A fragment of stone rim (5.9 x 1.2 cms) was found in A7/(3), 31 cms below the surface. It is very similar in shape and material to the other mortar fragment and may well have come from the same artefact.

6) Club head? (Fig. 8.8b)

A piece of triangular-sectioned stone ?club head (350.B7/(3)) was found in the upper horizon 48 cms below the surface. The broken central hole has been worked from both sides and has circumferences at each end of 12.5 and 11.9 cms. The segment is not symmetrical about the hole

¹ Chappell (in litt.) reports that the hornblende is not in equilibrium but is decomposing to ore and ore + diopside. A certain amount of diopsidic pyroxene has crystallised (at some depth) with the hornblende. There has been no metamorphism in the rock, the only secondary metamorphic mineral being analcite zeolite.

and if this object was a club it must have been considerably off balance. It may be a fragment of some other type of artefact.

7) Bone tools

Forty six pieces of worked bone were recovered, the majority of them being points of various kinds. Five distinct classes of points and one miscellaneous group are recognised.

i) Awls (6) (Fig. 8.4a-b). Three complete specimens are made from bird or bat long bone and retain a proximal epiphysis. Their lengths are 83, 79 and 63 mm., with diameters of 2.3-3, 2-2.4 and 2.3-3 mm. respectively. Three points similar to the whole specimens were also found. Local Siane and Chimbu informants recognised them as tools for making armllets of orchid fibre. (All specimens: upper horizon, towards the surface).

ii) Broad flat points made from split sections of long bone, probably macropod or cassowary (11) (Fig. 8.4e). All specimens are broken, 3 of them at the tip. Mostly concavo-convex in section, 5 of these points are fire-blackened in parts and one is heavily chewed by a rodent. They are much larger than most points from sites further east; only the large bipoint from Aibura is within their size range. (Four points: lower part of the upper horizon; seven points: lower horizon).

Table 8.5 : Broad flat points - measurements (mm.)

Length	41	24	56	16	66	41	35	22	>44	>33	>22
Width	>7*	10	12	7	13	10	9	9	11	14	8

Note: > implies that the tip is broken.

* partly broken.

These points may correspond to Bulmer's 'jabbers' found in Kiowa, levels 5, 7, 8, and 9.¹

iii) Bipoint (1) (Fig. 8.4c). This is a highly polished, blackened point. Its length is 54 mm., the cross-section is oval (5 x 3.3 mm.) and one tip is slightly broken. A slightly longer bipoint, rectangular in cross-section, was found at Kiowa, level 4.² (Upper horizon).

iv) Small flat spatulate points (4). The longest is 40 mm., the others are only tips. All have a cross-section of 3 x 1 mm., with rounded tips. (Three specimens: upper part of the lower horizon; one specimen: lower part of the upper horizon).

v) Heavy semi-cylindrical chunky points (3). The tips are made fairly abruptly but are not very sharp. The points are heavy, made from rounded sections of solid bone, bird being used in at least one case. Measurements

¹ S. Bulmer (1966), pp.102, 105, 106.

² S. Bulmer (1966), p.100.

are 31 x 7 x 5 mm., 37 x 6 x 4 mm. and 21 x 6 x 4 mm. All are broken. (All specimens: upper part of lower horizon).

vi) Miscellaneous small points (8). These are all short tips only (length 10-20 mm.), too heavy for awls but not classifiable with the other types. All are pointed and polished. Cross-sections range from oval to concavo-convex. (Four: upper horizon; four: lower horizon).

vii) Broken pieces of worked bone (9).

viii) A chisel-bevelled chunk of solid bone, with a high degree of use-polish on the bevel. Measurements 24 x 7.5 x 6.5 mm., length of bevel 10 mm. (Lower horizon).

ix) A flat-sectioned rectangular splinter of long bone (Fig. 8.4d). Highly polished, it is 41 x 3.8 x 1.4 mm., and has a very small hole bored through one end. The boring has been done from one side only. This is presumably a decorative piece and should be compared with a similar artefact from the lower levels of Aibura. (Near surface).

x) Three-quarters of a bone ring, 2 mm. thick, with an outer circumference of 10 mm. (Fig. 8.4h). The outer edges are bevelled. (Upper horizon).

xi) A piece of bird bone with one end rounded off. (Lower horizon).

The locations of some bone points from this site allow a tentative sequence to be suggested. The awls seem to be recent, being found near the surface: they have no parallels at Kiowa. The broad flat points, which are probably equivalent to Kiowa 'jabbers', are more common in

the lower horizon of Niobe, below the single bipoint: this is also the sequence at Kiowa.

If this pattern is compared with the Kiowa sequence, it may be argued that the lower horizon of Niobe is roughly comparable with Kiowa levels 4-8, while the tools in the upper part of Niobe are similar to those of Kiowa 1-2 (<c.5000 B.P.¹). Such a suggestion is speculative, particularly when the time range of particular bone artefacts is unknown, but it is clearly worth considering along with other evidence.

8) Ochre and ochre-knives

Large quantities of ochre were found, mostly in the lower part of the upper horizon. About 6 per cent of the pieces showed grinding or rubbing marks.

Table 8.6 : Ochre

Horizon	Number	Weight (gm.)	No. with use-wear
Upper	346	469.0	19
Lower	4	15.9	3

This ochre may have been used for painting rocks, bodies or artefacts.

Four stone flakes, two of them trimming flakes, show smears of ochre along one edge. All are from the upper

¹
S. Bulmer (1966), p.108b.

horizon. Three have ochre on one side of an edge only and these edges are unworn. The other edge is heavily worn and has ochre on both sides of it. There are more smears on one side and the ochre can be seen streaked at an angle of about 45° to the edge. This suggests that it was used to shave off ochre powder.

9) Miscellaneous stone artefacts

i) A small highly polished brown and white quartz pebble was found near the surface. Although naturally rounded it is much glossier than would be expected in a river stone; it may have acquired this gloss by being carried about in a soft container.

ii) A small chip of obsidian came from the upper horizon. This exhibits multi-directional grinding marks on one face.

10) Fossil shark vertebrae

Scattered vertically through the lower horizon in one square (Z7) were 4 large and at least 10 small annuli (Fig. 8.4f-g). They were originally identified as fossilised bone,¹ and then sent to Professor J.A. Garrick² who states, 'I would find it not unreasonable to accept them as parts of shark vertebra'.³ The four larger

¹
On the basis of a phosphate test, kindly carried out by Mr C.A. Key.

²
Dept. of Zoology, Victoria University of Wellington. Drs F. Talbot and J.C. Yaldwyn of the Australian Museum, Sydney, gave much help with these problematic specimens.

³
Garrick, in litt., 28/9/66.

vertebrae have diameters of 19-24 mm. and thicknesses of 3 mm., while the smaller vertebrae are 10-12 mm. in diameter and 3 mm. thick. Their distribution in Z7 is:

Spit	No. fragments	No. annuli	
		Large	Small
10	2	2	-
13	1	-	1
14	13	-	5+
15	4	1	3
16	1	1	-
17	1	-	1
Total	22	4	10+

The clustering suggests that most or all originally came from the same source, possibly a necklace or other decoration, since the central hole would make them ideal for stringing.

These specimens are heavily mineralised and dissolve entirely in HCl. In view of the unmineralised condition of other bones from the site, it seems that they must have been collected as fossils. Dr M. Plane¹ suggests that they would be more easily collected from tertiary mudstones a few miles west of Chuave, than from the local hard limestone which is not easily dissolved. All these marine formations might be expected to contain fossils of this type.

¹

Bureau of Mineral Resources, Canberra, pers. comm.

The use of fossils, usually mollusca, ammonites etc., was common in prehistoric Europe¹ and is known among Australian aborigines.² The use of fossil shark vertebrae has not been recorded in either area, although shark teeth have been found in many upper Palaeolithic sites.³ Fossils usually seem to have had a magical significance. In Melanesia coastal people are believed to make fossil foraminifera into necklaces,⁴ but this is the first record of the use of fossils in the Highlands, whether in prehistoric or modern contexts.

4. Flaked Stone Artefacts

1) Waste material

Nearly 10,000 pieces of unretouched and apparently unused stone were recovered. This waste material is in an overall ratio to flaked implements⁵ of 11:1. This is rather less than would be normally expected if all implements were knapped at the site. The ratio may be partly explained by the fact that the site is not very

¹ K.P. Oakley, 'Folklore of Fossils', Antiquity, XXXIX, 1965, pp.9-16 and 117-25.

² E.D. Gill, 'The Australian aborigines and fossils', Victorian Naturalist, 74, 1957, pp.93-7. (I owe this reference to Mr D.J. Mulvaney).

³ Oakley, 1965, pp.122-3.

⁴ J.C. Yaldwyn, pers. comm.

⁵ Defined as all pieces with secondary retouch or use-wear.

close to raw material sources¹ so that some roughing out was probably done away from the site, and more stones taken to the site were used as tools.

A wide variety of material was used. Black, non-greasy chert was the most common stone, but other cherts and some indurated shales were used. One variety of stone is commonly covered with a very thick soft yellow patina when excavated.

The amount of raw material in the four units of Z7 was calculated separately and the results are set out in Table 8.7. There seems to be little change in the flake:implement ratio over time in this sample square and none at all in the site as a whole.

Table 8.7 : Waste material - numbers

Horizon	Number	Number/cu. metre	Number/implement
Upper	5618	-	11.0
Lower	4297	-	10.9
Total	9915	ca. 1400	11.0
Z7/1-3	26	74	8.6
Z7/4-8	572	1634	11.4
Z7/9-13	1529	4369	10.1
Z7/14-20	1487	4249	11.3

¹
These are about 2 miles away.

2) Hammers

Eight river-pebble hammerstones were found, made of a variety of materials from feldspar-porphry to hornblende-diorite. All types of stone used bruise rather than shatter when struck. They are plentiful in the local streams half a mile or more away. Four pebbles are whole, two have large flakes removed and one is broken. The weights range from 63 to 1000 gm. Two intact pebble hammers - the largest and smallest - came from the lower part of the upper horizon. All others (weighing 169 to 705 gm.) came from the lower horizon. All were found towards the front of the excavation.

3) Trimming Flakes¹

These occur throughout the industry and there is an average of four for every seven flaked implements. There appear to be rather more implements per trimming flake in the lower part of the site, which suggests that implements were re-trimmed rather more frequently later in the site's history.

Table 8.8 : Trimming flakes - number

Horizon	Number	Implements/trimming flake
Upper	301	1.69
Lower	207	1.91
Total	508	1.72
Z7/1-3	1	3.0
Z7/4-8	36	1.4
Z7/9-13	88	1.8
Z7/14-20	72	1.8

¹ This class was not recognised at Kiowa.

The proportion of trimming flakes is high compared to other sites, especially Kafiavana.

4) Joins

Apart from the axe already mentioned¹ only two pairs of broken pieces were rejoined. One comes from the same square and spit, the other from adjacent spits in the same square.

5) Use-polished tools

Thirteen pieces with use-polish were found. Six are apparently whole or nearly whole tools, the others are broken. Only two are made of non-greasy black chert normally used for flaked artefacts. In many cases the use-polish is fairly faint and it is rather more difficult to classify it than that from Kafiavana. Many of the tools also have step-flaked edges.

i) Five pieces have bifacial use-polish similar to Kafiavana class 1 (Fig. 8.8a). The striations are all at right angles to the edge.

ii) One piece, a large chunky flake, has wear like class 1 but unifacial. This is similar to Kafiavana class 4.

iii) Three pieces have polish on the edge only and not on either face. All these are thin flakes and only one is broken. The nature of the wear is not determinable.

¹ See p.335.

iv) One small chip has use-polish similar to type 1; but about 10 per cent of the striations are angled some 15-20° away from the vertical, which suggests that the tool from which this came may have been used rather differently to, but on the same material as, class 1.

Three pieces, one of which is the migratory axe, have some remains of use-polish but are too broken or retouched for this to be classifiable.

Table 8.9 : Use-polished tools

Horizon	Class					Total
	1	2	3	4	Broken	
Upper	2	1	2	1	1	7
Lower	3	-	1	-	2	6

6) Flaked stone tools

The implements from Niobe have been classified according to the standard typology, but an attribute analysis has not been made. The flaked implements from this site are very similar to those from other sites described in this thesis, and such an analysis could have been made but lack of time, eyestrain and doubts about the stratigraphy of the site prevented it. The analysis of flaked implements is therefore not as full as at other sites.

i) Pebble tools (Figs 8.9, 8.10)

Thirty pebble tools were found, twelve in the upper horizon. Nearly all are made on light non-greasy chert, which feels slightly chalky. None are made on the dark chert commonly used for smaller implements.

All the pebble tools weigh between 134 and 1017 gm., but only two cores weigh more than 554 gm.

Table 8.10 : Pebble tools - weight

Horizon	Weight (gm.)					
	100-199	200-299	300-399	400-499	500-599	>599
Upper	1	2	5	2	-	2C
Lower	3+2C	4	1	3+2C	3	-

Six of the tools are unretouched but otherwise appear to be 'pebble tools'. They have been used as cores.

Upper horizon: Three are worked all round a base. One of these is nearly circular and looks a little like a 'horsehoof',¹ but with the central keel missing. Four are smooth oval river pebbles retouched on one side or end and one is worked round three sides. Several have clearly been used as cores prior to retouching.

Lower horizon: There is one classic, if small 'horsehoof' (Fig. 8.10b). Two tools are retouched on two planes and four are somewhat irregular chunks. Seven tools are smooth pebbles with retouch along a side or end.

¹ McCarthy, 1967, p.18.

The pebble tools show no obvious changes between upper and lower groups, but the numbers are too small to make useful statements.

ii) 'Scrapers' (Fig. 8.11)

Table 8.11 sets out the number of each class of tool in the two horizons. My general impression of this industry is that the implements are more heavily worked than at other sites, there are more chunky tools, both large and small, and 'multiplane' tools are more common.

Most tools are made of dark chert, with the common black non-greasy chert of the area being preferred. It is noticeable that more heavily retouched¹ tools are made in these cherts while less retouched tools are found in a wider range of materials and include some flakes which could have come from pebble tools.

Among the less retouched tools 'side' scrapers predominate. Neither these nor the 'end', 'double side' or 'side and end' tools provide examples of the thick, very heavily retouched tools which occur further east. Another interesting feature is that at least 15 of these tools would be called 'pebble tools' except for their small size.

Tools with more retouch tend to be smaller and many are heavily as well as extensively retouched. In the upper horizon the 'discoïd' scrapers are mostly retouched all round the base. A group of seven are almost circular, about 3 cm. in diameter and made on thick flakes. This

¹

This is an arbitrary classification.

type does not occur in the lower horizon where the tools which are retouched all round the base are flatter and more rectangular in shape. In the lower horizon there are two tools with deep concavities on either side of a ridge which recall similar tools at Batari.

The 'multiplane' tools are very chunky and often heavily worked. More of them have been used as cores than occurs at other sites. These tools also seem to be rather smaller than similar ones found further east. This is seen by comparing Tables 8.12 and the table on p.314: there are more light implements (<15 gm.) at Niobe than in all but Horizons I-II at Kafiavana. There are also many more 'multiplane' tools at Niobe than in Horizons III-IX at Kafiavana.

iii) Other tools

There are a few tools with scalar retouch on flat thin edges and three thin flat pieces with bifacial retouch or use-wear at one or both ends. This may be the result of a particular kind of use or it may be purely fortuitous.

Utilised flakes form only about 10 per cent of the industry. They are mostly small and thin, but a few larger ones occur.

iv) Comparisons with other sites

Comparisons with Kiowa site, which is closest to Niobe, are difficult for not only is my typology very different from S. Bulmer's but her sample is small - 288 retouched tools, 91 cores and 47 pebble tools - from a

deposit¹ ranging over more than 5,500 years. In general Kiowa seems to have rather more pebble tools (9.5 per cent of the total number of retouched and utilised pieces²), though this may be because of differing definitions of 'pebble tools'. Utilised pieces also seem much more common at Kiowa, where they consistently form 30 per cent or more of the total flaked tool assemblage.³ It is therefore impossible to compare the flaked tools from Niobe and Kafiavana satisfactorily.

Comparisons with Kafiavana suggest that 1) all the Niobe deposit is earlier than Horizons I-II at Kafiavana, since the percentage of utilised flakes is low at Niobe; 2) pebble tools are more common at Niobe suggesting a different tradition and 3) the presence of more small 'multiplane' tools suggests a more economical use of raw material at Niobe.⁴

On the basis of the flaked tools alone I am inclined to correlate Niobe with the main upper concentration of flaked tools (Horizons III-V) at Kafiavana and, very tentatively, with phases B and C at Kiowa.

¹ S. Bulmer (1966), p.108a.

² Total number 503. Cores are excluded since they are generally not retouched. See S. Bulmer (1966), p.132.

³ S. Bulmer (1966), p.108a.

⁴ There are too few implements of this kind in Kafiavana Horizons I and II (total 17) to make comparisons with these levels.

Table 8.11 : Tool types - number

	Horizon	
	Upper	Lower
1. Total tools	503	461
2. Whole retouched tools	193	201
3. 2 as % of 1	38.4%	43.6%
4. Utilised pieces	73	52
5. 4 as % of 1	14.5%	11.3%
6. Cores	7	8
7. Scrapers - total	174	184
- side	38	48
- end	12	19
- double side	11	10
- side and end	15	16
- double side and end	-	2
- double end	1	-
- discoid	11	12
- double concave	-	2
- miscellaneous	-	4
- multipiane	7	71
8. 8 as % of 7	79	38.8%
9. 'Bifacial' retouch/use	45.4%	1
10. Scler retouch	2	-
11. Pebble tools	5	18
12. 12 as % of 1	2.4%	3.9%
13. Broken retouched tools	211	189
14. 14 as % of 1	41.9%	41.0%

Table 8.12. i Weight of multiplane tools (per cent)

Horizon	Weight in gm.										Total	
	0-4	5-9	10-4	15-9	20-4	25-9	30-4	35-9	40-4	45-9		>49
Upper	2.5	16.5	19.0	15.2	13.9	12.7	2.5	2.5	2.5	1.2	11.4	79
Lower	1.4	16.8	20.8	16.8	6.9	13.9	4.2	2.8	4.2	1.4	11.1	72

5. Conclusion

Occupation at Niobe was clearly intensive. Large quantities of animal food were eaten there and a good deal of stone was knapped. The range of artefactual material suggests that a wide range of activities was carried out.

Occupation - though whether human or animal is not clear - appears to have begun in the old cave mouth and a deposit was built up. Some of the deposit was then concreted and further, definitely human occupation occurred in front and on top of the flowstone. The absence of hearths and other features may be related to the intensity of occupation as much as to exposure to the weather. At a late stage in the accumulation of the deposit considerable disturbance seems to have occurred so that the original relationship between particular artefacts may now be destroyed.

In very broad terms the sequence seems to parallel that found at Kiowa, with pebble tools, flake tools and some bone tools in the lower levels and the same material together with polished axe-adzes and domestic fauna above. There are some additional items of material culture not found at Kiowa - the use of fossil shark vertebrae in the lower level, the strange thin axe-like blades and the mortar fragments in the upper. Waisted blades seem to appear before axes and this has been noted in Yuku. Tentatively then the site seems to span all three of S. Bulmer's (1964) Kiowa stages. Further, the low percentage of utilised flakes suggests that intensive use of this part of the site ceased before at least 1000 B.P., while the large numbers of axes in the upper level,

together with the presence of bone awls still recognised as such by local people, seem to point to rather more use of Niobe compared to Kiowa in the more recent period.

It is unfortunate that S. Bulmer's and my typologies are so different that a comparative study of the flaked stone tools is very difficult. Unfortunately it was impossible to analyse both Niobe and Kiowa collections according to the same typology.

An interesting feature at Niobe is the presence of pebble tools in all levels: this was also found at Kiowa. In spite of difficulties in defining these tools and theorising about their use, it does appear that this feature differentiates both Niobe and Kiowa from sites further east. I do not know whether this is simply due to traditionally different techniques or arises from some different way of exploiting the environment: the first appears to be more likely, but remains a problem for future study.

CHAPTER 9

SOME ROCK ART FROM THE HIGHLANDS

The study of rock art is in many respects a separate branch of anthropological and prehistoric study. While archaeologists frequently hope to link the paintings on a rock wall to particular levels in the archaeological deposit beneath, this can rarely be done.¹ The paintings themselves do not usually provide internal evidence of their absolute date,² although relative dating is frequently used.³ A study of the motifs of rock art has been used to make deductions about the ethos of the painters, but in the absence of direct ethnographic evidence about the artists, all reconstructions must be very speculative.⁴ It is probably because of these limitations that prehistoric art is studied, in some respects, in isolation. Perhaps this is as it should be:

¹ A.R. Willcox, The Rock Art of South Africa, 1963, p.49; N.W.G. Macintosh, 'Dingo and Horned Anthropomorph in an Aboriginal Rockshelter', Oceania, XXXVI, 1965, pp.92-5 is an interesting but unproven attempt.

²

A rare example is the paintings of buffalo in North Australia which must date from the Nineteenth or Twentieth Century; see also Breuil and Lantier, 1965, Ch. 13.

³

E.g. Willcox, 1963, Ch. 9; Breuil and Lantier, 1965, Ch. 14.

⁴

See for example A. Leroi-Gourhan, Préhistoire de l'Art Occidental, 1965.

certainly, as J.V.S. Megaw recently pointed out,¹ there is a need for study based on principles of art criticism of 'style' etc., as well as on techniques and superpositions. This, however, is a study in its own right although one which can be done only when sufficient examples of the art are known well enough for comparative study.

This chapter attempts simply to list some of the art seen in the Highlands and to set out some considerations which must enter any interpretation. A comprehensive list of the art at Batari, Kafiavana and Niobe has been made (Appendix 9.1) and a full photographic record taken. At Aibura a number of paintings were photographed but I did not have time to make a full record. Many other sites where rock art is present were noted and it is hoped to study these more fully later.

1. Batari

Paintings are scattered along both the north and east faces of the creamy limestone cliff around Batari. Thirty-eight clear paintings were recorded; some very faded designs were omitted. Recording consisted of a sketch, written description and photographs.² No design was traced.

The designs fall into two clear groups - abstract forms (25) and hand prints (13). Among the former the Greek cross with outer enveloping line is common (7 examples) and there are also 3 figures with a vague

¹ In a paper to ANZAAS Congress, Melbourne, January 1967.

² Some of the designs are illustrated in White and White, 1964.

resemblance to a human. Circles do not form a basis for any of the paintings. Designs occur both in positive form, made in solid colour, or in outline.

Two of the pictures based on a Greek cross have been heavily scratched with a sharp instrument. The scratches did not simply remove the paint, they bit deeply into the rock. The marks are fairly fresh and unweathered.

The handprints are both positive, formed by dipping the palm in paint and placing it against the rock surface (7 examples), and negative, formed by stencilling (6 examples). None of the hands are mutilated in any way. From their size all would seem to be adult hands.

The colours used are red, yellow and white, with red predominating. Charcoal lines and other black drawings do not occur.

No information concerning the absolute or relative age of the paintings was obtained. None were covered by archaeological deposit nor were any Tairora people prepared (or able?) to say who had made them. Moreover, deductions about their age cannot be made according to their height above the present ground surface of the ground. At least 8 paintings cannot be reached without assistance today, three of them being more than 4 metres above the ground.

Some information was obtained about the meaning of the designs. Three old men of Himarata village happened to visit the site one day and were asked the name of each design. Questions and answers were put through a pidgin-Tairora interpreter. I had no opportunity subsequently to

check this information with other informants. The following interpretations were given:

All handprints were said to be the mark of the 'tambaran' or 'spirit'-owner of Batari cave, named Sirebo or Tirebo.¹ No distinction was made between positive and negative prints. The other designs fall into two main categories - small wild animals such as lizards, frogs and beetles (10 examples) and decorative materials like head-dresses, feathers and ceremonial designs (6 examples). In addition, they identified a self-portrait of Sirebo, a sea-shell, two trees and a tanket plant. One Greek cross was simply said to be like the cross on a medical orderly's laplap. As well as the self-portrait, one other of the paintings (no. 20) was said to have been actually made by Sirebo.

It is my impression that none of these interpretations are to be relied upon as identifying the objects the artist was intending to paint. It seemed however that a good deal of local knowledge and belief was being withheld and a detailed ethnographic field study might relate this rock art quite closely to certain aspects of Tairora life.²

The art seems to be local in origin and design. Handprints are unusual in the rock art of Papua-New Guinea. Although Bulmer has recorded them near Kundiawa³ they have

¹ This information was given to me during my original survey of this area (Chapter 2), as well as later.

² See the discussion of this problem in regard to the Kafiavana paintings (below).

³ S. Bulmer, n.d., p.25, site 57.

not been seen in other parts of the Highlands; nor is this motif normally used in decoration, at least in the Eastern Highlands.

The same is true of the enveloped cross motif. It seems unlikely that this is due to copying European medical symbols, which were seen only recently in this area. On the other hand, several Europeans did pass through the area during and after the Second World War and the design might have been copied then, though it is difficult to decide what it represents. It may of course be a much more traditional design. It is found scattered through Melanesia, as a design on tapa cloth in Astrolabe Bay,¹ and in petroglyphs on New Hanover² and New Caledonia.³

2. Aibura

A very large number of paintings occur in Aibura. They are found on all walls of the east and west chambers, on the south wall of the main chamber and in a very small cave on the west side of the outcrop. None occur on the

¹ T. Bodrighi, 'New Guinea Style Provinces. The Style Province of Astrolabe Bay' in T. Bodrighi and L. Bolgar (eds), Opuscula Ethnologica Memoriae Ludovici Biro Sacra, 1959, Fig. 42, p.90.

² A. Buhler, 'Steingeräte, Steinskulpten und Felzeichnungen aus Melanesien und Polynesien', Anthropos, 41-4, 1946-9, pp.262-3; R.J. Lampert, pers. comm.

³ L. Chevalier, 'Nouveaux pétroglyphes du Nord calédonien', Études Mélanésiennes, n.s., 12-13, 1958-9, Figs 9, 14, 15, 19.

west wall of the main chamber, which is the main wall behind the excavation.

The colours used are black and white only. Two methods of applying the white can be seen, the more common one consisting of rows of white dots and the other of solid lines and smears. Black normally occurs in thin lines, as if drawn with a dry charcoal stick, but occasionally black paint seems to have been used. Most designs using black occur on the north wall of the west chamber and in the small western cave.

Many of the pictures are superimposed on others drawn in the same fashion. Many also are covered with soot, which has turned them brown or grey. The decipherment of such a palimpsest would have taken more time than was available and only some of the clearer forms have been recorded.

Most of the paintings are abstract designs, but there is one clear female figure and two designs which resemble lizards. Among the abstract designs the only recurring patterns are circles and an irregular triangle with two small projections from its apex. Because of the complexity and multiplicity of the designs I have included several plates rather than an attempt to describe them (Plates 9-3, 9-4). Together with those already published,¹ they give a reasonable sample of this art.

The 'white dot' method of painting is unlike any previously recorded in other parts of the Highlands,

¹ White and White, 1964, Plates 4, 5, 10, 13.

though I have found it in Oriaka shelter in the Lamari R. valley, about 8 miles south of Aibura. Fortunately I was able to obtain some information about the technique.

While I was excavating Aibura a middle-aged Tairora man from Barabuna village, called Na'oh, came uninvited to Aibura and started to make a design on the roof of the west chamber (Plates 9-1, 9-2). I questioned through an interpreter about both design and technique. He said that the 'paint' used was white ash obtained by burning dry grass and sifting out the impurities. This ash contains many short hair-like fibres. It is stored in a roll of leaves.

For painting a handful of ash is moulded lightly in the palm of the hand. A pinch is taken between thumb and forefinger and applied to the rock surface, being pressed into place with the thumb. No liquid is mixed with the ash, nor is there any pretreatment of the rock. As careful study of some paintings showed thumbprints on some of the dots, it seems that this method is a standard one for producing these pictures.

Little information was obtained about the meaning of the various designs and none about the place of this art in Tairora life. Na'oh asserted that the design he was painting had no meaning or story attached to it. He did not explain why he was painting at that time. He did however volunteer to identify some of the other Aibura designs. On one afternoon he named thirty-four designs, including a head-dress, drum, necklace, garden fence, roof, bow and arrow, snake, a lizard, several birds, the sun, men and spirits. He said that he could not identify four pictures. Six days later he re-identified twenty of

the same designs, giving consistent answers in only four cases. Little reliance can therefore be placed on these identifications as identifying the objects painted by the artist. But it is my impression that the paintings do have names and a meaning within north Tairora life and that this could be obtained in an intensive ethnographic study.¹

3. Kafiavana

Paintings and Engravings

Paintings occur in two shelters on Koyagu hill and there are several engravings on an isolated rock outcrop about half a mile north of Legaiyu village. No detailed study was made at any of these sites, but a complete photographic coverage has been made and some ethnographic information about the paintings in Kafiavana shelter recorded. Plates 9-5--9.10 show some of the paintings. A descriptive list of individual pictures is given in Appendix 9.1. Numbers used in the text refer to this list.--

1) Kafiavana

Rock paintings occur along 8.6 m. of the back wall of the shelter and are spread from 0.8 to 3.2 m. above present ground level (Plate 9-5). A total of 77 designs was counted, the main concentration (55 designs) being

¹ For an example of this type of work see A. Forge, 'Art and Environment in the Sepik', Proceedings of the Royal Anthropological Institute for 1965, pp.23-31.

directly above the excavation and for two metres to the left¹ of this. Of the total number about half are extremely clear and many others are only slightly faded. This is true even in places such as the extreme left, where water trickles down the rock face during rainstorms. Elsewhere in the site there are some traces of very faded paintings, but these were not recorded in detail. Paintings in the right 3.6 m. of the panel (nos. 56-76) are less clear than the others, possibly because they are more exposed to the weather. All but one of the designs are non-representational. Most are geometric, comprising circles, lozenges, triangles and rectangles. There are many minor variations, but the following main motifs occur:

(1) Circles (total 50)

i) Segmented (total 33). The most common form is a white circle, divided inside into segments of different colours. Often the centre is marked by a dot or circle (axle) from which radiate spokes (usually white), dividing each segment from the next (total 20). The whole design often has the overall appearance of a spoked wheel. The segments are most commonly coloured alternate red and black, but blue-grey and yellow-brown are sometimes found. The segments vary in number from four to twenty, with four or eight being the most common.

Paintings with coloured segments (33). Numbers 2, 3, 10, 12, 13, 14, 17, 18, 20, 20A, 24, 25, 26, 27, 29, 30,

¹ All directions are taken standing in the shelter and looking at the back wall.

31, 32, 33, 40, 41, 47, 49, 54, 55, 56, 57, 58, 63, 64, 65, 67, 68.

Paintings with central axle (24). Numbers 2, 3, 14, 18, 20A, 24, 25, 26, 27, 29, 30, 31, 32, 33, 40, 47, 49, 54, 56, 63, 64, 65, 66, 67.

Paintings with spokes (19) - white: Numbers 2, 3, 12, 13, 26, 29, 31, 40, 41, 47, 49, 63, 65, 66, 67;

- black: Numbers 27, 32,

56;

- red: Number 54.

ii) Other internal divisions (total 18). There are many other forms of internal division including inner circles and crosses. Numerous small rays around the outer edge of the circle occur in 9 cases. Numbers 4, 5, 7, 8, 9, 11, 15, 16, 28, 34, 35, 42, 43, 61, 62, 66, 70, 72.

(2) Multiple lozenges (total 5). Three of these are outlines and two are in solid colour. Three have the lozenges joined at the sides, one at the ends and in one they are not joined.

Numbers: 22, 22A, 38, 69, 71.

(3) Hourglass (total 4). These are formed from two triangles placed apex to apex.

Numbers: 6, 53, 60, 73.

(4) Rectangles (total 3). With drawn diagonals.

Numbers: 1, 45, 50.

(5) Multiple triangles (total 2). Placed base to apex, side by side.

Numbers: 30A, 44.

There are four figures (19, 23, 37 and 39) which might be interpreted as schematic humans, but the purely naturalistic painting of a bird (48) is quite exceptional. One suspects that it was made more recently or for a different reason, but Legaiyu men did not seem to regard it as different in any way from the other paintings.

The colours used are black, white, one or two reds, yellow-brown and a very bluish-grey. The rate of weathering seems to be the same for all colours.

No absolute dating of the designs is possible as no fragment of rock with the remains of a painting on it was found in the deposit. Other excavated materials, including ochre pieces, flakes apparently used for cutting ochre and pebbles on which ochre was probably mixed with liquid do not necessarily relate to the rock paintings and in any case occur throughout the depth of the excavation.

Relative dating, by the study of superpositions, is occasionally possible, but the earlier designs seem not to be technically or stylistically different from the later.

As well as archaeological evidence, some ethnographic evidence was collected about paints and the designs which helps in interpreting and dating the art.

Colours

Most of the pigments (gouvi)¹ used today in Legaiyu village are collected from the bed of Fenome stream, about 1½ miles 10°E of N of Legaiyu. Iron oxides² provide a bright and a dark red (kora'ago), a purplish-red (kukupu'ago) and yellow-brown (nupagubi'ago), while white (fumapa) comes from shale.² Another type of red is an iron oxide cement² dug from the side of a small hill of brecciated limestone about half a mile East of Fenome. Charcoal provides the basis of black paint. All these colours are very similar to those of the rock paintings and probably these were the pigments used. I could get no information about the bluish-grey colour used in the paintings.

It seems likely that a brush and liquid paint was used for painting at Kafiavana for the colour is applied evenly and lines are fairly straight even on rough rock surfaces. The liquid may have been plant juice such as is used nowadays for mixing with pigments.³ Pigments are pulverised today by scraping a lump of ochre with a sharp stone flake; the excavation of similar flakes with red ochre along their edges as well as eighteen lumps of ochre with signs of rubbing or scratching suggests that the prehistoric practice may be similar to the present one.

¹ The orthography is my own.

² Identified by Mr C.A. Key.

³ See Ch. 4, arrow painting.

Motifs

Several older men of Legaiyu claimed that they knew the name and meaning of each design and this information was collected in one day at the end of the field season when about five of these men were invited to the site.¹ Another complete check was not made but any visitors to the site during the entire field season were questioned. Their answers were consistent with the other information. In addition Dr R. Wagner² collected (in pidgin) the names of nine designs when he visited the village for a few days in November 1964.

Of the nine Yagarua names he collected, three are consistent with my information, three are different but describe similar objects and three are different in both name and object described. This is not a very high correlation and yet, in the initial stage in the study of Highlands rock art, it seems worthwhile to put these local ascriptions on record. The meaning of these ascriptions is discussed later.

¹ Each design was sketched and given a number by my wife. I recorded all questions, discussion and descriptions on tape, referring to the number for identification.

Dr S. Wurm, Department of Anthropology (Linguistics), A.N.U., has listened to some of the tape and informs me that the discussion between informants was about the question being asked not about the meaning of the design.

² Then of the University of Washington New Guinea Native Religions Project.

The most common name, given to 37 designs, was sarumane¹ (a hornbill, Rhyticeros plicatus). This name was given to all but 3 (Nos. 20, 41, 54) of the circles with coloured segments, including all but one (No. 54) of the 24 circles with a central axle, and all but two (Nos. 41, 54) of the 19 circles with spokes. It was also given to six of the eighteen circles with other forms of internal division. One series of zigzags (No. 59) was also called sarumane.

My informants stressed that these designs were only 'named after' a hornbill, unlike all other designs which actually represented something.

Further names for circles included kēnevi, a star (5), and yego, the sun (2).

Names for other motifs included birds, insects, reptiles, a crustacean and parts of plants. The birds ranged from local species such as kisereyave, possibly a swiftlet (Collocalia sp.), to one which is now only found in the rain forests near Okapa, dedekopa, which may be a Bird of Paradise. The reptiles include a lizard,

1

The orthography has been given by Mr J. Prentice and Dr D. Laycock of Department of Anthropology (Linguistics), A.N.U. According to Dr S. Wurm, the names are given in the Kisivaroka dialect of Yagaria language. This dialect is normally used by the Lutheran Mission and seems to have been regarded as the correct one to use when talking in the presence of Europeans (although I could not speak it). The home language of Legaiyu village is the Kami dialect. The words are pronounced with vowels as in Italian. g is pronounced as the Greek gamma; (na, ne) seems to be an article; the t in bat'e is a long t, possibly glottalised.

dogorum(na) and a frog, huva(na), but no snakes were mentioned. The crustacean, okera, is either a freshwater crab or a crayfish.

Both cultivated and wild plants were named, including yegerutuna(na) (bananas), kayave (pandanus nut), beniva (seeds of the hoop pine) and a fern leaf, haveva.

The only human figure was that of a baby (bat'e) while man's material culture was represented only by an hourglass drum (yauga) and clothing (fepe, ?neenbege).¹

Three things emerge from a study of these names. There is the concentration upon the natural part of man's environment as opposed to his material culture, gardening or husbandry. Then there is the distinction between a design as a representation and one 'named for' something, a distinction which raises interesting problems. Third, although there is sometimes a correlation between name and design there is no case where similar designs, as we see them, are all given the same name.

There is, however, a more general problem of meaning which needs to be discussed. This arises from work done by Dr C. Berndt in the Kamano speaking area east of Legaiyu.² Among the emblems used in ceremonies there is

¹
My orthography.

²
C.H. Berndt, 'Ascription of Meaning in a Ceremonial Context in the Eastern Central Highlands of New Guinea', in J.D. Freeman and W.R. Geddes (eds), Anthropology in the South Seas, 1959, pp.161-84. Dr Berndt has also given me access to her unpublished notes on the kafi zafa design and has made some very helpful comments. I wish to express my thanks.

one (kafi zafa) very similar to the Kafiavana sarumane, while the general style of designs is common to both areas. Berndt's work on the 'meanings' of these emblems in ceremonial contexts suggests that currently used designs are usually interpreted differently by different people. Thus she says -

Although most adults seem to have some idea of what emblems should be like and can outline the main features of a kafi zafa, a zagu, and so on, this does not mean that they can identify any particular emblem in an actual ceremony, or that their interpretation of it would agree with that of the person who is displaying it. Perhaps because of this, in all the ceremonies I attended people who were asked about the meaning of a specific emblem always insisted that only the bearer would know.¹

This is not to say, however, that the meaning of a design is completely random. Berndt records that while kafi zafa can be interpreted as the sun, it is more usually said to be a hole in a tree or rock. In other words its interpretations cover a limited range. In use, however, it usually has a specific and localised meaning, with the wearer referring to a specific tree, rock or hole. Each time an emblem is used it has a specific personal relevance as well as its social range of meanings.²

If Berndt's assessment can be applied to some extent outside the Kamano area - and there seems to be no good reason against this - then it suggests that only the

¹ Berndt, 1959, p.175.

² Dr R. Wagner has made the same point to me about designs generally when discussing the Kafiavana paintings. In litt., 7/9/66.

makers of the Kafiavana designs could say what they 'represent'. It may be that the current village symbolizations do relate, in some broad way, to those of the prehistoric artists. No very good method of checking this is readily available, though it might be assumed to be more likely if the rock-paintings were not very old.

It is very clear, however, that to use directly the information from Legaiyu villagers to interpret this art would be misleading.

Dating

Several lines of argument suggest that these paintings are pre-European but are probably not older than a few hundred years.

Informants claimed that all the designs except one were made by their forefathers (pidgin: tumbuna) in particular Hagunapa, a third or fourth generation ancestor of at least one villager (Losevi) and generally regarded as the founder of Legaiyu. The absence of European motifs, which are seen in other caves in the Eastern Highlands¹ supports the suggestion of a pre-European date.

The paintings are however unlikely to be more than a few hundred years old as they are too exposed to the tropical environment to survive indefinitely.² The fact that local people, who do not possess long historical traditions, can name and identify the designs may support

¹ White and White, 1964, p.779.

² Cf. Willcox, 1963, Chs 8 and 10.

the idea that they are relatively recent. In this regard it is interesting that one picture (70), although nominally and stylistically similar to the others, was pointed out immediately as being the only recent creation, apart from a few childrens' scrawls in charcoal.

It might also be argued that since there are no paintings below or very close to present ground surface, they must have been drawn from it. However there are one or two paintings more than 3 m. above the present surface and to reach these some artificial assistance would have been needed. All paintings might therefore have been done in this way and need not relate to the present ground surface at all.

The designs of these rock paintings are still used in Legaiyu village. The church is decorated with many motifs similar to this art, although executed in poster-paint. Also, at the Goroka Show in August 1964 a number of shields carried by men from the Asaro valley bore designs very similar to the Kafiavana paintings. Some Legaiyu men said, quite independently of this, that people from other villages came to look at the rock paintings and copy the designs to use for decoration.¹

2) Patadzavana

This small (4 x 2 m.) rock shelter is located on the west side of Koyagu hill, near its summit. The shelter has only 1.5-2 m. head room, the floor is rocky and there

¹

This information was also given to Wagner (in litt., 7/9/66).

is no sign of anything other than casual occupation. Ten paintings were recorded. All are crudely done with coarse lines; nine are in red paint and one in black. Designs, especially the black ones, are similar to those found in Kafiavana, and the colours appear to be similar. Data from local informants as to the date and meaning of these paintings was unfortunately not collected.

3) Kedawa'aipa

This is a large calcareous sandstone boulder about one-third of a mile north of Legaiyu village. Sited at the top of a small rise, it forms a local landmark, and the main path to Kami estate passes by it. On the boulder are a number of engraved and scratched designs (Plate 9-11). The three techniques of abrading, drilling and scratching¹ seem to be employed.

These designs are certainly recent and are still in use as part of the non-material life of Legaiyu people. Two men said they were associated with ceremonies to increase the number or fatness of pigs, but their precise place in these ceremonies was not determined. Legaiyu people seemed embarrassed when asked about these engravings, and one of the designs was mostly chipped away between my visits in November 1964 and March 1965. Interestingly, a Chimbu man who accompanied the author in

¹ Using the terminology of McCarthy where applicable; see F.D. McCarthy, 'The Classification of Techniques and Styles in Australian Rock Art', Australian Institute of Aboriginal Studies, mimeo., n.d., p.2.

1964 picked up a particular piece of this stone, whitish in colour with a dark vein in it, and took it back to the Chimbu valley with him. There, he said, he would pulverise it and give it to his pigs so that they would grow fat.

4. Niobe

Many of the limestone cliff faces near Niobe are painted and to list fully all the pictures would require considerable time. I have listed and photographed most of the paintings which occur on the cliff within about 100 metres of Niobe shelter. Plates 9-12 and 9-13 are examples. In many cases the paintings are almost inaccessible and this made accurate recording difficult.

A total of thirty-four designs was recorded (see Appendix 9.1). They are usually placed in isolation but in one case nine are crowded into an area of about 80 x 100 cm. (nos. 8, 9, 10, 11, 12, 28, 29, 30, 31). The most common design is a circle (24 examples), which in seven cases is divided internally into segments of different colours. External rays are found in nine cases. Other designs include ovals, crosses and a few semi-representational figures. The tradition of inscribing rocks is still current as is shown by some careful charcoal lettering.

Only four colours are used - black, yellow and light and dark red. No colour predominates. Nineteen of the designs are monochromatic, the rest mostly bichromatic. Paint appears to have been applied as a liquid rather than as a dry crayon.

Two young Siane men who worked for me said that the segmented circles, at least, were painted when an important man was killed in battle. Similar information, though covering a broader range of designs, was given to S. Bulmer in 1959-60.¹ Further information about the meaning, interpretation or dating of the designs was not collected, nor can it be deduced from the designs themselves.

One interesting feature is the similarity between the segmented circles of Niobe and Kafiavana. This complex design does not appear widely in the Siane area (absent at Fikombara, Parro, Limuku, Kimeo, ?Kiowa shelters) nor is it found further west in the Chimbu region. It has not been noted elsewhere in Papua-New Guinea.

5. Conclusions

Nearly all Eastern Highlands art is abstract, and few naturalistic or semi-naturalistic designs have been found. In this there appears to be a slight contrast with the Western Highlands, but this may be simply because little rock art has been recorded in detail there.¹

From the present records it would be premature to attempt any major delineation of style areas. It is apparent however that there are some similarities between the art at Kafiavana and Niobe and other shelters in the Chuave area. It seems that current native interpretations of this art differ widely in the two areas suggesting that

¹ S. and R. Bulmer, 1964, p.59.

² For a summary see S. Bulmer (1966), pp.76-7.

similarity in design is not the result of recent close contact. Given that the sites are only 20 miles apart some links are not surprising even though the Siane tend to be linked with the Western Highlands in most other features.¹

The presence in the Lamari valley of two art forms distinctive in both technique and style is more unexpected. Both are within the Tairora language area² and one valley system: the two forms even seem to overlap north of Obura. There is no evidence that these forms differ widely in date, and it seems more likely that they do not. If the postulates of Watson's Microevolution Study are correct³ then one might speculate that this art, being so different, must be fairly recent. This suggestion needs to be checked by further study.

In the Tairora area it has not so far been possible to see whether native interpretations of this art and its place in native life differ markedly between northern and southern Tairora: this might throw some light on the physically expressed differences between the paintings.

The most interesting feature to emerge is the possibility of probing more deeply into the meaning of

¹
Read, 1954; S.A. Wurm, 'Australian New Guinea Highlands Languages and the Distribution of Their Typological Features', American Anthropologist, 66(4), Part 2, 1964, p.83.

²
Although in different dialect areas. A. Vincent, pers. comm.

³
Watson, 1963, pp.189, 191.

rock art in the area. The inferences made about the art at Kafiavana on the basis of Berndt's article must be restricted to that area for the present, but a wider study of native meanings and interpretations of art would probably allow wider theories, perhaps with more direct implications for prehistory both in the Highlands and elsewhere.

CHAPTER 10

EXCAVATIONS AT KOSIPE, CENTRAL DISTRICT, PAPUAIntroduction

The presence of an archaeological site at Kosipe Catholic Mission was first noticed in 1960, when mortars, axes and waisted blades were found during excavations for church foundations. Word of this site was sent to Mr W.E. Tomasetti,¹ who informed me of it in 1964. I excavated there from 18th to 24th June 1964. In 1966 the site was visited by Dr K. Crook² who collected further soil and carbon samples. Work on this site is still proceeding.

Kosipe lies about 75 miles north of Port Moresby and 11 miles north northwest of Waitape Patrol Post, Central District, Papua (147° 16'E, 8° 21'S). Its altitude is about 6,100 ft M.S.L.

The Mission occupies a sloping flat-topped ridge which is one of a number of parallel ridges fingering down from the south into Kosipe swamp. The ridge is bounded on the east and north by the Ivane River and on the northwest by Popo Creek (Fig. 10.1). The main hills on both sides of the swamp run up to about 8,000 ft and are heavily dissected. They are covered with rain forest.

¹ Then Assistant District Officer, Tapini.

² Department of Geology, S.G.S., Australian National University.

The swamp is overgrown with pandanus. Scattered areas have been cleared for gardens (Plates 10-1, 10-2).

The people of this area are known to administrators and ethnographers as Goilala but call themselves Iauade. A group of Tavade speakers who call themselves Iveiava live in Paimuru village about half a mile from Kosipe, on the other side of the Ivane River. They cultivated the present mission site about 50 years ago.

Excavations

The ridge is about 150 m. wide at the point where the mission buildings are located. To the south, uphill, it broadens rapidly to become ca. 800 m. wide only 400 m. from the mission.

The mission church lies about 30 m. above swamp level on the eastern side of the ridge. Artefacts seem to be concentrated particularly around the church, but have been found over the entire area of the mission buildings and gardens, about 60,000 sq. m. (600 are).

In 1960 Fr Willem found 23 artefacts during excavations for the church foundations. He reported their location as follows:¹

Now for the location of the latest find:² right in the middle of the Kosipe station on the top of the main ridge running down to the Popo-Ivane junction.

¹ Fr Willem to W.E. Tomasetti, 28 April 1960.

² I am told that Fr Willem had found individual artefacts throughout the district previously.

Description of the levels -: Top layer of black humus, about 10" deep - middle layer of clay (just over a foot) - bottom layer of black soil : finds at 12 to 14" from the top of this last layer.

Numerous remains of fireplaces (i.e. ashes, black sooty, 1 to 2" layers, in different spots) on the same level.

Fr Willem's account of the stratigraphy is supported in most instances by my own excavations.

Some of the artefacts were sent to Mr Tomasetti in Tapini, but none can now be traced there or in Port Moresby. Twelve pieces were kept at Kosipe, of which eight are prehistoric implements and four are probably not artefacts. Since these artefacts come from the same stratigraphic position as those excavated in 1964 they have been included with them.¹

In 1964 two areas were excavated² (Fig. 10.1):

- (1) An area of 32.8 square metres³ at the south end of the church was dug to a depth of 80-100 cm. (Fig. 10.2).
- (2) An area of 10.5 sq. metres was excavated 65 m. north of area (1). It was dug to a depth of 80-100 cm.

Within each excavation unit (3 squares in area (1) and 1 in area (2)) each visible layer was removed

¹

I am very grateful to Fr Gasser for permission to remove these artefacts temporarily from New Guinea for study.

²

For a preliminary report see White, 1965a, pp.41-3.

³

The irregular size is due to the irregular profile of the section cut for the church.

separately. Vertical slices 1-2 cm. wide were cut with a spade and the earth was broken up before removing it. All artefacts were thus found before removal from the soil and their exact position recorded. Sieving of the soil was not carried out except for a trial period: the soil was too stiff and the artefact yield too small to make sieving worthwhile. All excavation was done by four Gollala men.

Five visible strata were recorded (Plates 10-3, 10-4):

1. Upper humus, with many roots and much carbon, 10-25 cm. thick.
2. Orange-brown clayey soil, little carbon, 30-50 cm. thick.
3. a) and b). Brown to brown-orange soil clearly divided into two levels, both with some carbon and artefacts. The upper level is rather darker than the lower, although the exact boundary is often diffuse. Most artefacts are found around the junction of the two levels, usually about 25-30 cm. below the top of 3a). Total depth of 3., 30-55 cm.
4. Orange clayey soil, sterile. Developing rapidly into
5. Weathering bedrock.

This stratigraphy is very similar to that found by Fr Willem who did not, however, notice that level 3 was divided into two parts. My excavations showed no trace of fireplaces or hearths in level 3: all the carbon I found there was in separate fragments free from any sooty or ashy matrix. It is possible that fireplaces did occur in this soil but it seems unlikely.

A total of 7 implements, 3 dubious pieces and 13 chips of stone was excavated in 1964. No bone material was found nor any other artefacts apart from carbon. Three implements were found in situ in exposed sections outside the excavation area and have been included in the total.

Radiocarbon dates

Three radiocarbon dates have been obtained:¹

Level 2.	ANU-21	4050 ± 500 B.P.
Level 3.	GaK-624	16300 ± 1200 B.P.
Level 3.	GaK-625	19350 ± 600 B.P.

Professor K. Kigoshi² reports that there may be some error in GaK-624 deriving from incomplete pre-treatment owing to the low amount of carbon in the sample. This suggests the date may be somewhat too young.

All dates are from loose lumps of carbon or from carbonaceous soil. None of them come from a hearth or other definitely human feature.

The significance of these results will be discussed later.

Ecological Data

1. No faunal material of any kind was excavated.

¹
Dury, 1966, p.162.

²
Faculty of Science, Gakushuin University, in litt.,
27/7/65.

2. Soil samples from layers 1-4 were submitted to Dr J.M. Matthews.¹ He reported² that samples were treated with acridin orange 1 per cent solution and examined with a fluorescence microscope. They showed the following results:

Kosipe 1, 12 cm. below surface. Pollen is present: a preparation could probably be made.

Kosipe 2, 28 cm. below surface. Pollen is sparse: a preparation might possibly be made.

Kosipe 3, 55 cm. below surface. Occasional pollens: probably insufficient for a preparation.

Kosipe 4, 85 cm. below surface. None observed.

Dr Matthews was unable to identify any of the pollen, but reports that sweet potato (Ipomoea batatas) did not seem to be present.

Implements

Three main types of implements occurred, namely mortars, waisted blades and flaked or ground axe-adzes. Flakes and dubious implements were also found (Table 10.1).

Implements were mostly found in layer 3, as Table 10.2 shows.

¹ Then attached to the Department of Geography, I.A.S., Australian National University.

² In litt., 22/1/65.

Table 10.1 : Kosipe - artefacts

	1960	1964	In situ collection	Collected in village	Total
Mortar	2	-	-	-	2
Waisted blade	2	3	2	4	11
Axe	3	4	1*	-	8
Flakes	-	3	-	-	3
Dubious	-	13	-	-	13
Natural stones	4	1	-	-	5
Total	11	24	3	4	42

Table 10.2 : Kosipe - stratigraphic distribution of artefacts

	Level					
	2	2/3a	3a	3a/3b	3b	Not rec.
Mortar	-	-	-	-	-	-
Waisted blade	-	1	2	-	2	-
Axe	1*	-	-	1	3	-
Flake	-	9	1	-	-	2
Dubious	-	-	1	-	3	-
Total	1	10	4	1	8	2

* This implement was found by Crook in 1966 near excavation area (2).

Of the thirteen implements found in situ in 1964-6 all except two were clearly located in level 3. One is located at the interface of 2 and 3a. Crook's implement was about 45 cm. below ground surface, well down in level 2. This ground axe may be in situ, deposited during gardening operations later than the deposition of layers 1-2; or it may be disturbed from level 3 by vegetational activity, such as a tree root. Crook is inclined to regard it as undisturbed, which would make this axe younger than the implements in level 3.

The implements in levels 3a and 3b are clearly in situ. Dr Crook wrote from the site: '...anything in layers 3a and 3b was put there before layers 1 and 2 were formed. It just does not seem possible to have gotten anything in from the present surface'.¹ His detailed study of the surficial geology (Appendix 10.1) confirms this statement.

1) Mortars (Fig. 10.4)

Both these were collected in 1960. One is whole, the other a broken fragment.

a) The whole mortar is made of a hornblende-porphry and is very weathered. It is rather crudely hollowed out of an asymmetrical piece of rock. The bowl is 12.5 x 11.5 cm. and slightly over 4 cm. deep. With the mortar resting naturally one side of the bowl is 2 cm. higher than the other. It weighs 2.87 kg.

¹
In litt., 11/8/66.

b) The fragment is made of tuff. It comes from a large dish or bowl and is ornamented with a row of bosses around the outer edge of the rim. The diameter of the bowl is about 19 cm., and the depth probably more than 4 cm. There is no sign of a foot and the object was probably simply rounded at the base. The bosses around the rim are rounded knobs, each about 3 cm. in diam. and 1 cm. high. The width of the rim varies from 2.5 to 3.7 cm. It weighs 1.13 kg.

2) Waisted blades (Fig. 10.5a-c,e)

The waisted blades from Kosipe are very varied in length and width. Their defining characteristic is a flaked indentation on either side about the same distance from the end. The cross sections are always lenticular. Most are made in phyllite,¹ a very common rock in the area.

Table 10.3 gives the measurements of these specimens according to the method given in Chapter 3.

¹ Identified by Dr Crook.

Table 10.3.1. BUIFA - Village B/10th. measurements (cont.)

Ref.	1 ₁	1 ₂	1 ₃	1 ₄	Re 1	Re 2	Re 3	Th 1	Th 2	Th 3	Ground/vegetation	Comments
IVD1	12.4	3.2	1.2	2.1	20.2	3.4	3.2	2.2	1.1	1.2	100	Very weathered surface
IVD2(-)	8.2	3.0	1.2	2.9	5.1	4.2	2.5	1.6	1.4	1.6	100	Surface is bare
IVD3	15.1	6.0	1.8	3.1	20.1	9.2	8.2	3.4	2.6	2.9	100	Surface is bare
Section D)	12.8	2.5	1.8	6.0	21.4	6.1	5.2	1.4	2.4	2.4	100	Surface is bare
Section V)	17.9	9.2	3.1	3.0	13.6	10.0	11.9	2.1	3.1	3.1	70	Surface as shown up to 100% on the wall
Cell 196	18.7	11.1	1.4	2.6	13.4	12.2	11.8	2.1	1.8	1.8	100	One face is vertical
Cell 196	13.4	4.0	1.5	2.6	6.4	6.4	2.6	2.6	2.1	2.4	100	
Village ^a	14.6	8.1	2.9	2.6	8.7	8.2	7.6	3.2	1.8	2.0	100	
Village ^b	9.2	2.2	n.m.	2.0	7.6	n.m.	3.8	1.2	0.8	1.0	100	Overlaid
Village ^c	15.0	3.6	2.4	4.1	20.2	9.1	7.9	2.9	2.7	2.8	100	
Village ^d	11.4	4.0	2.2	2.4	7.0	3.7	6.2	1.4	1.4	1.2	100	

^a Reference number = square/structure.

^b These implants were purchased from villagers.

3) Axes (Fig. 10.5d,f)

Of the eight axes four are whole and four are broken. Only two axes are partly ground, both near the cutting edge; all other axes are flaked.

The two partly ground axes are both made of phyllite, are about the same size and are ground similarly around the cutting edge.

Coll 1960: Length 11.2 cm., width 4.4 cm., max. thickness 1.5 cm.

Coll 1966: Length 11.6 cm., width 4.3 cm., max. thickness 2.4 cm. (level 2). The cross-sections of both are lenticular, though with flattish faces. Both are symmetrically beveled, with slightly squared-off butts. The cutting edges are curved and slightly asymmetrical in plan.

The two other whole axes were both collected in 1960. One is made of a very weathered tuff containing many hornblende crystals. This axe is roughly quadrangular in cross-section with flattish faces and sides. It is asymmetrically beveled. Longitudinally one face is convex, the other flat. The sides are curved in plan so that the axe flares out towards the cutting edge, which is the widest part of the axe. The point of maximum thickness lies about halfway along the axe.

Length 22.3 cm., breadth 13.8 cm., thickness 3.5 cm.

The other whole axe is an asymmetrical chunk of phyllite. Approximately triangular in shape it appears to be broken rather than flaked into a trapezoidal cross-section. The cutting edge is highly convex, beveled

slightly by flaking and set very close to the wider of the two faces.

Length 19.7 cm., breadth 9.1 cm., thickness 3.5 cm.

The four broken axes were all excavated in 1964 from the south end of the church.

(i) The cutting edge and part of the body of a broken axe, probably made from a phyllite river pebble. The cutting edge is very convex, set asymmetrically to the main thickness of the axe, but is only slightly beveled by flaking. The cross-section is lenticular and the sides parallel.

Width 6.8 cm., thickness 3.9 cm.

(ii) The cutting edge and part of the body of a very roughly flaked axe made in weathered tuff with hornblende crystals. The cross-section is roughly quadrangular with flattish faces and sides. The cutting edge is beveled asymmetrically and, when viewed end-on, is seen to be set slightly skew to the faces.

Width 6.3 cm., thickness 3.1 cm.

(iii) The cutting edge only of a phyllite axe. Symmetrically beveled, one side of the cutting edge may be ground but the other is clearly flaked.

(iv) Part of a thin flake off a large phyllite river pebble lightly flaked to form the cutting edge of an axe. The tool is of flat-convex cross-section. The blade is convex in shape.

4) ?Artefacts

The three dubious pieces comprise: one possible flaked axe, one stone ball very similar to those called kulki in Australia¹ and one ?flaked object.

5) Flakes

Two of the flakes are of quartz, the rest are phyllite. None of them show any signs of secondary working and only some show bulbs of percussion.

Interpretation

The soil profile in which the artefacts lay was initially puzzling² and it was only interpreted through the co-operation of Drs K. Crook and B.P. Ruxton.³ They have shown that the soil on Kosipe ridge accumulated from the deposition of volcanic ash derived from Mt Lamington, 70 miles southeast (Appendix 10.2). Some of this ash has been heavily weathered in situ and this is the cause of the darker, more humic layers. It also seems likely that there has been local redeposition of ash but only within a short time after the original ashfall (see Appendix 10.1).

Until Dr Ruxton analysed these soils it was thought that only two or three ash falls were involved. It now

¹ McCarthy, 1967, p.55.

² Mr A Lang, B.Sc., Patrol Officer at Waitape was most helpful in discussing the site with me in 1964 though our conclusions have proved to be unsound.

³ Division of Land Research, C.S.I.R.O.

appears that there may be more, but present soil sampling does not allow this to be checked. Ruxton and I plan to visit the site in August 1967.

On the basis of the five samples Ruxton has analysed,¹ however, some interesting points emerge and some correlations with the Managalase sequence from Mt Lamington² are possible. They are shown in Fig. 10.3.

Ruxton shows that the artefacts are contained in Natanga and perhaps upper Sagamasi ash (Kosipe level 3). They are clearly sealed in by Silimbu ash (Kosipe level 2). The position of most artefacts well into level 3 rather than at the 2/3a interface suggests that they were not contained in a now-eroded ash, but were included in level 3 by human activity either during its deposition or while the land surface was forming at the top of it. This is also Crook's conclusion.

It is clear from the work of Crook and Ruxton that the artefacts are dated to between ca. 4,000 B.P. and 16-19,000 B.P., but within this range several alternative dates are possible:

(i) The artefacts date to around 15,000 B.P. or more and are in situ in the Natanga ash. This implies that they were deposited before and during this ash-fall.³

¹ See Appendix 10.2.

² B.P. Ruxton, 'Correlation and Stratigraphy of Dacitic Ash-fall Layers in Northeastern Papua', Journal of the Geological Society of Australia, 13, 1966, pp.41-67.

³ Note that these ash falls may occur as several smaller units separated by some time: Ruxton, 1966, p.62.

Crook shows that there are no good geological reasons against this at present, and there are arguments in its favour. Some of the archaeological considerations will be discussed later.

(ii) The artefacts were in use during the weathering of layer 3 (Natanga ash) and were then sealed in by Numba ash so that they date to between 8,000¹ and 15,000 B.P. Crook suggests this as a minimum age. However the Numba ash has so far been definitely noted only in discontinuous patches at Kosipe. Further soil sampling is needed to see if this highly distinctive ash seals in the artefacts, giving them a firm terminus ante quem.

(iii) If the artefacts are not sealed in by the Numba ash, then it can be said only that they are older than 3,000-5,000 B.P.² The discovery of other Mt Lamington ashes at Kosipe may of course alter this picture.

Any assessment of the nature of the occupation at Kosipe, of course, depends not only on its date but also on our knowledge of the history of horticulture and its associated artefacts in the Papua-New Guinea Highlands.³ I wish now to argue the case that there is currently no good evidence against Kosipe being a pre-agriculturalists'

¹ Ruxton, pers. comm. estimates that the Numba ash is probably around 12,000 years old.

² ANU-21 \pm two standard deviations.

³ I am aware of the dangers in using primarily New Guinea Highlands evidence when discussing the Papuan Highlands; but it seems to me that at present altitude should take precedence over political boundaries.

site, even if the chances are perhaps rather in favour of it belonging within the agricultural phase.

First, the oldest definite date for agriculture in New Guinea (from the Manton site, Mt Hagen) is 2,000-4,000 B.P.¹ Its high development at ca. 2,000 B.P. suggests it is rather older than this date: it therefore probably overlaps with the younger part of the Kosipe date range.

Secondly, the main stone artefacts excavated at the Manton site were ground axes and axe-sharpening stones.² Waisted blades were not found there. This is surprising in view of the frequent interpretation of these as hoes, or similar agricultural implements which should be even more directly associated with gardening than axes.³ This suggests that waisted blades may not always be associated with agriculture; this may be confirmed by the Yuku site where they precede that 'pre-condition' of agriculture,⁴ the ground axe.⁵ It is also relevant that very similar artefacts to the 'tanged' variety of waisted blades occur in non-agricultural Australia.⁶

¹ R.J. Lampert, 'Horticulture in the New Guinea Highlands: Carbon dates from a Recent Excavation', Antiquity (forthcoming).

² Lampert (1966), p.7.

³ S. and R. Bulmer, 1964, pp.65-6; S. Bulmer, 1964a, p.259.

⁴ S. and R. Bulmer, 1964, p.66.

⁵ S. Bulmer (1966), pp.115-136. This non-association was recognised by S. and R. Bulmer, 1964, p.65.

⁶ McCarthy, 1967, p.51 and Fig. 40.

Thirdly, it has been frequently argued that a complex of artefacts including some or all of pestles, mortars, bird and animal figurines, quadrangular ground axes, pottery, pigs, bows and arrows was introduced to New Guinea by an agricultural people some time in the past.¹ S. and R. Bulmer conclude from a review of pestles, mortars, figurines and clubheads in the Highlands that they 'did not precede the introduction of agriculture to the Highlands'.² I think that this claim is not yet soundly based.

There is so far no direct association between agriculture and mortars and pestles in the Highlands, for they have never been recorded in contemporary manufacture and use by current Highlands populations.³ This is somewhat curious especially among the taro-eaters, where pounding of food is a more common procedure than in areas dominated by sweet potato. Such a complete absence is also unexpected in view of the general stability and persistence of most Highlands artefact types.⁴

¹ E.g. Riesenfeld, 1950, pp.666-7, 669; C. Schmitz, 'Steinerne Schalenmörser, Pistille und Vogelfiguren aus Zentral-Neuguinea', Baessler-Archiv, n.s., XIV, 1966, pp.50-8 (this section was translated by Mr P. Lauer); R.N.H. Bulmer, 1964, pp.147-50.

² S. and R. Bulmer, 1964, p.72.

³ The evidence of J.M.A. Chappell, 'Stone Mortars in the New Guinea Highlands: a Note on their Manufacture and Use', Man, 64, 1964, pp.146-7, is completely at variance with other information from the Highlands and cannot be regarded as completely reliable.

⁴ Lampert (forthcoming); S. Bulmer (1966), p.115, 138; this thesis, passim.

The use to which these artefacts were originally put is unknown. S. and R. Bulmer have argued several times that although introduced by an agricultural people, they were mostly used in non-agricultural activities such as the grinding of edible wild seeds and nuts.¹ The fact that mortars and figurines found now in native gardens are frequently regarded as magical² is good reason for suspecting that their original and normal use, even if this was not entirely utilitarian,³ has been forgotten. It is also worth noting that stone mortars are well known from non-agricultural contexts elsewhere in the world,⁴ although the Highlands examples seem to be rather more elaborately made than most others.

The argument that a complex including these artefacts arrived from outside New Guinea along with agriculture also depends on the discovery of suitable points of origin.

¹ S. and R. Bulmer, 1964, p.70; R.N.H. Bulmer, 1964; Chappell, 1964.

² R. and S. Bulmer, 'Figurines and Other Stones of Power among the Kyaka of Central New Guinea', Journal of the Polynesian Society, 71, 1962, pp.192-208; R.M. Berndt, 'Contemporary Significance of Prehistoric Stone Objects in the Eastern Central Highlands of New Guinea', Anthropos, 49, 1954, pp.553-87.

³ S. and R. Bulmer, 1964, p.70.

⁴ In Australia, see D.S. Davidson and F.D. McCarthy, 'The Distribution and Chronology of Some Important Types of Stone Implements in Western Australia', Anthropos, 52, 1957, pp.436-47; for America see H.M. Wormington, Ancient Man in North America, 4th ed., 1957, pp.65 and 202-4. H.E. Driver, Indians of North America, 1961, pp.69-70 concludes that mortars date to 5,800-9,000 B.C.

Thus Schmitz¹ derives the form and decoration on mortars and pestles from Indonesian bronze and ceramic prototypes though he is not at all specific as to the latter's dating and economic association. In these areas too the use of the term 'Neolithic' refers to the presence of polished stone and pottery² neither of which, in themselves, are diagnostic of horticulture or husbandry. It must be further pointed out that except for the last two or maybe three millenia there is no dated archaeological evidence of horticulture or animal husbandry in presumed S.E. Asian or Indonesian 'homelands'. This is not to say such evidence will not be found. Sauer's idea of Southeast Asia as an independent centre for the early domestication of some plants is so far unproven,³ but the recent radiocarbon dates for ceramics more than 10,000 years old in Japan and possibly Formosa⁴ show that surprises may

¹ Schmitz, 1966, pp.55-6.

² H.R. van Heekeren, 'The Stone Age of Indonesia', Verhandelingen van het Koninklijk Instituut voor Taal-, Land- en Volkenkunde, 21, 1957, pp.116-33; F.L. Dunn, 'Radiocarbon Dating of the Malayan Neolithic', Proceedings of the Prehistoric Society, n.s., XXXII, 1966, pp.352-3.

³ C.O. Sauer, 'Agricultural Origins and Dispersals', American Geographical Society, Bowman Memorial Lectures, series 2, 1952, pp.24-33. Compare J.D.G. Clark, World Prehistory - An Outline, 1961, pp.201-2.

⁴ K-c. Chang and M. Stuiver, 'Recent Advances in the Prehistoric Archaeology of Formosa', Proceedings of the National Academy of Sciences, 55, 1966, pp.541-2. Japanese dates announced at Eleventh Pacific Science Congress, Tokyo, 1966: D.J. Mulvaney, pers. comm.; see also T. Oba and C.S. Chard, 'New Dates for Early Pottery in Japan', Asian Perspectives, VI, 1962, pp.75-6.

well be in store. At present however if mortars and pestles are in New Guinea more than 4,000 years ago then their links with agriculture are purely presumptive.

I think therefore that it is possible that mortars and pestles were commonly used in hunter-gatherer contexts as well as in later economies.¹

Finally, the presence of two partly ground axes tells us little about the date or economic associations of Kosipe. As has been shown in Chapter 7, ground stone axes are at least 10,000 years old in New Guinea and are twice this age in other parts of Australasia.² Like mortars and pestles, they are not definite evidence for agriculture.

The three types of artefacts and the little evidence available for agricultural history therefore cannot, at present, tell us even whether Kosipe records the presence of gardeners or hunter-gatherers. This site, however, is worthy of further research: closer study of the volcanic ashes is already planned, but the possibility of pollen studies in the several square miles of Kosipe swamp remains to be explored.

¹ Apart from Chappell's evidence (1964), the presence of stone clubheads? and stone rings at Aibura and the fragments of mortar at Niobe and the Mt Hagen site (Lampert (1966), p.7) clearly show the association with later economies. See also Blackwood, 1950.

² White, 1967.

CHAPTER 11

TOWARDS A PREHISTORY

In the last decade suggestions about the course of Highlands prehistory have been made by workers in several fields. There has been reasonable consistency between these theories, all of which pointed to migrations of various kinds into the Highlands, mostly from the east.¹ Further work however seems to suggest that some of the more simplistic ideas need re-examining, and this will now be done. Following this a general survey of the archaeological data will be made and a synthesis attempted.

Linguistics

S.A. Wurm has shown that 50 Highlands languages, spoken by 96 per cent of the present population, belong to one Stock.² This stock is distantly related to languages outside the Highlands, in the Huon Peninsula, Northern District and middle Sepik. Five families occur within the Stock. The East (E) and East Central (EC) families which are found east of Chuave are closely related, while Central (C) and West Central (WC) have a large number of cognate words. EC and WC are typologically similar but C

¹ S. and R. Bulmer, 1964, pp.41-52 for an able summary.

² Wurm, 1961, pp.114-6; Wurm, 1964, pp.77-97; S.A. Wurm, 'Language and Agriculture in New Guinea', New Scientist, 31, 1966, pp.216-8.

is typologically rather different from other Highlands families. Both lexical and typological features show a major linguistic boundary between Chuave (C) and the Asaro valley (EC). Glotto-chronological dating suggests that languages within the different families of the Stock started to diverge 3000-4000 years ago, while sub-families became apparent only 1000-2000 years ago.¹

Wurm points out that the numerically and territorially large languages are mostly centrally located in the Highlands while smaller languages and other un-related languages are all found on the fringes, suggesting that they are linguistic remnants. Further, since the numerical and territorial area of individual languages increases from East to West, Wurm suggests that the East may have been the longest occupied. He supports this by showing that Huon Peninsula languages are typologically most similar to the E and EC languages.

Cutting across this east-west pattern to some extent is the evidence which suggests that the still-spreading C family forms a wedge between the typologically more similar EC and WC families. There are also the weak similarities between the Telefomin, the Ndani and the E and EC languages of the Stock to be explained.

The historical picture given by the linguistic evidence per se is not yet entirely clear. In his most

¹ Cf. H. McKaughan, 'A Study of Divergence in Four New Guinea Languages', American Anthropologist, 66(4), Part 2, 1964, pp.99-102.

recent paper¹ Wurm's prehistory relies to a large extent on the interpretations of Robbins (plant ecology), S. and R. Bulmer (archaeology) and Macintosh (blood groups). He suggests that the initial occupants of the Highlands spoke languages ancestral to the Stock. Some of these languages were spoken by the first agriculturalists and these expanded through population growth and 'prestige bilingualism'.² Early in the agricultural period and well before the advent of the sweet potato,³ other peoples, speaking languages distantly related⁴ to the Stock, moved into the E, EC and Huon Peninsula areas. Beyond the EC-C border the migrations were much smaller, possibly of displaced persons. These took agriculture with them and their linguistic expansion⁵ absorbed or displaced some of the older languages. It is the small scale of the migration which allows the archaeological picture of continuity (found especially at Kiowa) to emerge.

Wurm's construct cannot be fully tested with the limited archaeological data so far available. If the theory is true however then there should be considerable similarity between the later material cultures of the

¹ Wurm, 1966.

² Wurm, 1966, p.218.

³ McKaughan, 1964, p.119 suggests that the Kainantu family has been in the area for at least 1,000 years.

⁴ Wurm, 1966, p.218.

⁵ This presumably includes the Central group, but this has not been explicitly stated.

eastern Highlands and the Huon Peninsula. In addition strong links should be found with the Markham valley; the almost complete absence of pottery from the Highlands suggests that this link is not very strong.

It also seems that Highlands archaeological culture exhibits a fairly high degree of similarity throughout the prehistoric period. There are of course differences, but it does not appear that these occur either all at one time or even within the presumptively horticultural period; they may indeed stem from the earliest settlement. Thus Wurm's postulate of one or more major migrations is not entirely in accord with the archaeological evidence. But it must also be pointed out that correlations between linguistic and archaeological evidence are often difficult to make and it may be unfair to both disciplines to attempt them in the early stages of their work in a particular field. Even apart from the general difficulties of glottochronology,¹ it can be argued that since different types of data are being used, partially differing results need not be unexpected. This is not to say that either discipline is more accurate in reconstructing prehistory but simply that each may be dealing partly with a different sort of prehistory.² The problems of correlating these in the Highlands remain to be investigated.

¹ See e.g. G.W. Grace, 'Movement of the Malayo-Polynesians: 1500 B.C. to A.D. 500. The Linguistic Evidence', Current Anthropology, 5, 1964, pp.364-5; also K. Bergsland and H. Vogt, 'On the Validity of Glottochronology', Current Anthropology, 3, 1962, pp.115-153.

² Cf. F.T. Wainwright, Archaeology and Place Names and History, 1962, pp.45-8 and passim.

Human Biology

Several biological studies, mostly of blood groups, have shown various continuities and discontinuities within the Highlands population.¹

In a recent study,² for instance, the blood groups of a random sample of 1000 people were recorded from members of Wurm's EC, C and WC language families. In terms of the ABO, MNS and Rh systems there were no significant variations within these groups. Between the families however EC-speakers differed significantly from the others in terms of ABO and Rh while C- and WC-speakers were unlike in terms of MNS. In the MNS system EC-speakers were more like WC than C.

This contrasts somewhat with earlier studies which found significant differences in ABO, MNS and Rh systems between groups within the areas covered by Wurm's EC³ and C⁴ language families.

The clearest blood group gradient found so far in the Highlands is the rise in frequency of the S gene towards the west. Walsh⁵ interpreted the figures available in

¹ See the list in S. and R. Bulmer, 1964, pp.44-5.

² A.P. Vines and P.B. Booth, 'Highlanders of New Guinea and Papua: A Blood Group Survey', Oceania, XXXV, 1965, pp. 208-17.

³ Kariks. et al., 1960, pp.234-5.

⁴ R.J. Walsh, J.L. Jameson and O. Koopzoff, 'Blood Groups and Haemoglobin Values of Natives from Minj, New Guinea', Oceania, XXXI, 1960, pp.80-1.

⁵ Macintosh. et al., 1958, pp.173-98.

1958 as showing a sharp break at the Chimbu-Asaro divide. The figures available by 1961¹ were:

Area	Number in sample	S - positive (%)
Kainantu	375	8.5
Goroka	123	12.2
Goroka	2123	16.5
Chimbu	64	23.0
Chimbu	864	27.4
Chimbu-Mt Hagen	235	28.1
Mt Hagen	473	28.8
Western Highlands	2608	37.0

It seems to me that with further studies the evidence is less favourable to a 'break' than it was in 1958, although the overall picture of a cline is confirmed.

These and other blood group studies have been interpreted as showing population migrations. In 1958 Walsh suggested² that there could have been an infiltration of a group of people east or west along the Highlands ridge, but said that this must be documented by the discovery of other gradients showing a similar pattern

¹ R.T. Simmons, J.J. Graydon, V. Zigas, L.L. Baker and O.C. Gajdusek, 'Studies on Kuru. V. A Blood Group Genetical Survey of the Kuru Region and other Parts of Papua-New Guinea', American Journal of Tropical Medicine and Hygiene, 10, 1961, Table 6; see also R. MacLennan, M. Bradley, and R.J. Walsh, 'The Blood Group Pattern at Oksapmin, Western Highlands, New Guinea', Archaeology and Physical Anthropology in Oceania, II, 1967, pp.60-1.

² Macintosh et al., 1958, pp.191-2.

to the S gene. In the same paper Macintosh¹ wondered whether the blood group evidence could be interpreted as showing that Highlanders were the product of hybridisation between an earlier group of people who occupied the whole island, and a later migrant wave. He found the evidence was not fully able to support this idea.

Freedman and Macintosh² have recently put forward a similar theory. After studying the stature of 2,248 Western Highlands Enga males, they theorise that originally the stature of New Guinea's population was similar over the entire island. Within the Highlands local evolution of 'pygmies' occurred and later there were migrations from the east coast into this area. They suggest that these migrations occurred following 'explosive population increases on the coast, perhaps due to the introduction of the sweet potato there'.³ In the light of current theories concerning the date of arrival of the sweet potato in New Guinea,⁴ these migrations must have occurred rather less than 300 years ago. It is therefore difficult to relate this conclusion to linguistic, archaeological or anthropological evidence.

The other interpretation of biological variations within the Highlands is that they are largely the result

¹ Macintosh et al., 1958, pp.193-6.

² L. Freedman and N.W.G. Macintosh, 'Stature Variation in Western Highland Males of East New Guinea', Oceania, XXXV, 1965, pp.300-2.

³ Ibid., p.302.

⁴ See below, 'Ethnological Reconstruction'.

of random genetic drift or local selective forces. For example, after a thorough survey of the literature in 1961, Simmons et al.¹ concluded:

It is considered that the apparent phenotypic heterogeneity of the natives of New Guinea is largely the result of differentiation developing from a small, reasonably homogeneous population which spread gradually to many relatively isolated regions, and that over the centuries diverse types have evolved which show variations both in physical characteristics and in blood group gene frequencies.

A similar statement was made more recently by Giles,² while MacLennan and his co-authors also come to this conclusion when considering the blood group pattern at Oksapmin and surrounding areas.³

It may be concluded that it would be unwise to use the migrations suggested by some human biologists as the basis for a prehistory since not only is there no agreement among specialists about the interpretation of results but also the date given to these migrations is difficult to correlate with other evidence.

¹ Simmons, et al., 1961, p.662.

² E. Giles, 'The Prehistoric New Guinean. In Chuave, 8000 B.C.', New Guinea, I (6), 1966, p.23.

³ MacLennan et al., 1967, pp.60-1; see also F.B. Livingstone, 'Blood Groups and Ancestry: A Test Case from the New Guinea Highlands', Current Anthropology, 4, 1963, p.541-2.

Plant Ecology

Stabilised short grasslands occur in many places just below the lower zone of Highlands settlements. These grasslands are widest in the east where they merge into the extensively grassed Markham valley. It is commonly accepted that much of this grassland occurs because of man's activities such as clearing and burning.¹ Robbins² has claimed that continuing human re-use of land produces a general floristic sequence of forest clearance, followed by tall Miscanthus re-growth, which in turn gives way to stabilized Themeda disclimax.

Robbins also shows that while forest clearance in the Eastern Highlands is almost complete so that new gardens are made in the regrowth, new garden plots in the Western Highlands are usually made on the forest fringes. He interprets this to mean that the Eastern Highlands have been settled longer and more extensively than the Western and suggests that the vegetation pattern records the introduction of agriculture into the east and its later spread into the west, either by adoption or human migration. He believes the Highlands grasslands are at least several hundred years old.³

Robbins considers that the same floristic succession from forest to grassland occurs also on the Ramu and middle Sepik plains⁴ and, for the middle Sepik at least,

¹ Brookfield, 1964, p.32 and refs.

² Robbins, 1963a, pp.52-3.

³ Robbins, 1963a, esp. p.54.

⁴ Robbins, 1963b, esp. pp.315-9.

he and Reiner have accounted for the current vegetation pattern in terms of a human migration.¹

A critical review of Robbins' theory about Highlands vegetation has not been made, but Brookfield has drawn attention to the importance of poor soils, low rainfall, amount of sunshine and diurnal range of relative humidity in determining the floristic sequence following human interference.² He points out that in different environments the effects of continuous re-burning or cultivation may be very different and suggests that the 'empty' grasslands may be so because they are inimical to resettlement by either forest or man.

It is also worth noting that the first detailed study of the floristic succession in an abandoned garden was published only in 1966.³ Walker shows that around Lake Ipea in the Western Highlands Miscanthus is likely to become established in an abandoned garden where pigs are common and firing rare while Imperata dominates when these factors are reversed. This study covers a period of only a few years and the long term sequence is as yet unknown.

Further, it must be remembered that at least some grassland was present on some valley floors at some stage

¹ E.J. Reiner and R.G. Robbins, 'The Middle Sepik Plains, New Guinea', Geographical Review, 54, 1964, pp.20-44.

² Brookfield, 1964, p.33.

³ D. Walker, 'Vegetation of the Lake Ipea Region, New Guinea Highlands. I. Forest, Grassland and "Garden"', Journal of Ecology, 54, 1966, pp.503-33.

in the Pleistocene.¹ Valley floors provide much of the area of grassland today, so that it may be germane to enquire whether they were ever in fact forested.

It is perhaps also relevant, though rather less directly so, to consider the criticisms made by Haantjens and others of the Reiner and Robbins hypothesis about the middle Sepik plains.² They point out that 90 per cent of the grasslands occur on soils which have drainage problems and are lacking in nutrients, while more than 90 per cent of the forests occur in the valleys on better drained, less weathered and more fertile soils. This forested zone is also a more favourable environment for gardens, and most gardens are now made there. They therefore consider that environmental rather than human factors are responsible for the forest-grassland boundary. They believe that while forest in the valleys is able to regenerate fully and so appear virgin, forest regrowth in the other areas is prevented by the combination of poor soils and fire-liability.

This visualisation of the grasslands as a dynamic system has obvious relevance for the Highlands. Although it remains to be shown that environmental differences can account for the general pattern of Highlands grasslands, it is clearly necessary to examine this possibility before accepting the human use of land as the sole cause of

¹ See Appendix 7.2.

²

H.A. Haantjens, J.A. Mabbutt and R. Pullen, 'Environmental Influences in Anthropogenic Grasslands in the Sepik Plains, New Guinea', Pacific Viewpoint, 6, 1965, pp.215-9.

permanent grasslands. Until this is decided Robbins' theory of an east to west migration must remain in abeyance.

Ethnological Reconstruction

The most comprehensive theory of Highlands prehistory to be based on synchronic evidence has recently been published by J.B. Watson.¹ Using 'ethnological reconstruction' he suggested that the advent of the sweet potato (Ipomoea batatas) in the Highlands led to an 'ipomoean revolution' whose effects were 'basic, sweeping and impressively similar...over much of the area in question'.² Since the sweet potato is presumed to have arrived in Melanesia only within the last 400 years,³ this revolution with its important economic, social and demographic consequences occurred only very recently. Watson suggests that before this revolution the Highlands 'were occupied by scattered bands of hunters practising supplementary cultivation'.⁴ Such cultivation consisted of scattered plantings of crops like taro, bananas and sugarcane. These people 'knew and planted crops but depended heavily on wild food sources for subsistence, and adjusted their movements as much in response to the requirements of foraging as out of concern for their plantings'.⁵

¹ Watson, 1965a, 1965b.

² Watson, 1965b, p.441.

³ Watson, 1965b, pp.439-40; Yen, 1963; Conklin, 1963.

⁴ Watson, 1965a, p.301.

⁵ Watson, 1965a, p.301.

The basis of Watson's theory seems to lie in his interpretation of the social anthropology of the Central Highlands. He believes that:

the tentative and provisional character of social arrangements, the compromise and opportunism of aboriginal politics, group instability - related in part, at least, to warfare - and individual variability of ritual and supernatural belief suggest that these people have not been settled horticulturalists for very long.¹

He suggests that the recent adoption of sweet potato horticulture by such groups as the Daribi and Huli is the final phase of this wholesale commitment to sweet potato.²

Sociologically, he believes that patrilocal bands are the best model for pre-ipomoean social structures.³ The sweet potato caused a 'population explosion',⁴ a change in work patterns⁵ and an increase in warfare.⁶ It also produced 'certain broad tendencies' including

¹ Watson, 1965a, p.295.

² Watson, 1965a, p.301.

³ Watson, 1965a, pp.305-7. Compare however the comments of W. Shapiro, 'On Patrilocal Bands', American Anthropologist, 68, 1966, pp.1498-1502.

⁴ Watson, 1965b, pp.444-5; 1965a, p.302.

⁵ Watson, 1965a, p.445.

⁶ Watson, 1965a, p.447.

(1) patrilineal emphasis or ideology; (2) widespread existence of clans or quasi-clan lineage groupings; (3) importance of the sibling link; (4) a sharp dichotomy between the sexes, often accompanied by an expressed horror mulieris; (5) 'looseness' of structure; (6) flexibility and relative ease of affiliation with consequent ramification in a fairly open system of land rights; (7) prevalence of warfare; and (8) leadership based primarily upon achievement and prowess rather than on lineage seniority, inheritance, or other ascriptive qualifications.¹

Any final assessment of Watson's theory will depend, in part, on the criticisms of social anthropologists, regional geographers and demographers. Some of them have recently pointed out² that his theory is internally inconsistent and does not take sufficient account of the similarities between the Highlands and lowlands New Guinea societies. They believe that a population explosion on the scale suggested by Watson, with an increase of 1.5 per cent or more per annum, is demographically highly improbable and they also find it difficult to believe that the present widespread very complex and efficient system of gardening could have developed from a hunter-gatherer society within the last 400 years or less.³

¹ Watson, 1965a, p.304.

² At a seminar on 'Agricultural Evolution in the New Guinea Highlands' at the Research School of Pacific Studies, A.N.U., 24-27 April, 1967. A report on this seminar is being prepared for publication: H.C. Brookfield and J.P. White, 'Revolution or Evolution in the Prehistory of the New Guinea Highlands?'

³ Prof. M. Meggitt has also suggested that political organisation among the Mae Enga is unlikely to have differed much for the last 100 years or more. Seminar, Dept. of Anthropology, 15 May 1967.

One archaeological site is directly relevant to a discussion of Watson's theory. This is the complex of water control ditches excavated at the Manton site near Mt Hagen in 1966.¹ These ditches occur over at least 800 acres in a present peat swamp. Wooden digging sticks, a paddle-shaped wooden spade, fence posts and ground stone axes with their sharpening stones were found in the ditches. A wooden digging stick has been dated to 2300 ± 120 years (ANU-43), while human activity post-dates 4600 ± 140 B.P. (ANU-44). The artefacts cannot be distinguished from modern horticultural tools,² while the pattern of ditches seems to be similar to that still in use in the Baliem valley³ or on the hill-slopes of the Mt Hagen area itself.

This site must be taken as proving the existence of horticulture at this early period, and it is clearly not sporadic or the simple, extensive, forest-fallow rotation type which may have been the original form in the Highlands.⁴ However, even if it is probable that this

¹ J. Golson, R.J. Lampert, J.M. Wheeler, and W.R. Ambrose, 'A Note on Carbon Dates for Horticulture in the New Guinea Highlands', Journal of the Polynesian Society (forthcoming); Lampert (forthcoming).

² Lampert (forthcoming).

³ L.J. Brass, 'Stone Age Agriculture in New Guinea', Geographical Review, XXXI, 1941, p.568 and Figs 8, 10.

⁴ W.C. Clarke, 'From Extensive to Intensive Shifting Cultivation: A Succession from New Guinea', Ethnology, V, 1966, p.347; see also H.C. Brookfield, 'Local Study and Comparative Method: An Example from Central New Guinea', Annals of the Association of American Geographers, 52, 1962, p.252.

site does not represent the primary pattern of Highlands horticulture, it could be argued that the time needed to develop this form need not be very great.¹ This site therefore might occur quite early in the history of horticulture in the area, although there is no evidence, of course, that this is so.

This archaeological site clearly refutes a basic part of Watson's hypothesis. The Manton site can scarcely be thought of as a completely unique phenomenon - similar systems probably occurred in other Highlands valleys for example. There is therefore good reason for saying that the sweet potato may well have had much less effect on many Highlands cultures than Watson believes, and its advent may have very few archaeological correlates.

Archaeology

The only Highlands prehistory to be based on excavated archaeological data has been written by S. and R. Bulmer. They have suggested two constructs,² the second of which depends to a much greater extent upon a presumed economic history than the first. Both constructs were based largely on the evidence from Kiowa and Yuku sites. This evidence is summarised in Figs 11.1 and 11.2.

¹

Compare for example the apparently rapid adaption of sweet potato horticulture to New Zealand conditions by the Polynesians. See D.E. Yen, 'The Adaption of Kumara by the New Zealand Maori', Journal of the Polynesian Society, 70, 1961, pp.338-48.

²

S. and R. Bulmer, 1964, pp.72-4 and S. Bulmer (1966), pp.156-8.

In 1964, before radiocarbon dates were available, S. and R. Bulmer suggested Highlands prehistory should be divided into three phases. Phase I (Kiowa A) saw the region occupied by 'pre-neolithic' people lacking edge-ground implements. They must have been hunters and gatherers or, if people had only recently entered the Highlands, they may have practised a limited horticulture.

In Phase II (Kiowa B, Yuku A-B) a number of new implements were introduced, namely the lenticular-sectioned axe-adze, flaked waisted blades (possibly hoes or digging tools) and the pestle-and-mortar complex of artefacts, which was associated with the introduction of agriculture, or at least new crops. The similarities in details between Highlands stone mortars and figurines and northern coastal examples may indicate an immigration of people to the Highlands, but the other excavated artefacts show little evidence of technological discontinuity with Phase I.

Phase III (Kiowa C, Yuku C) was marked by the planilateral-sectioned axe-adze and, in the Eastern Highlands, pottery-making. The evidence of the flaked tools does not suggest any considerable break with the preceding phase.

S. and R. Bulmer pointed out that intensive sweet potato cultivation probably occurred within Phase III and that before this crop was available the altitudinal limit of settlement was probably lower. They suggested that if the continuity visible in the technology occurred in other fields, then some languages of the Highlands Phylum were being spoken in the Highlands as early as Phase I times.

They concluded that although Eastern and Western Highlands may have had slightly different histories 'there is no archaeological evidence for or against a single main migration into and through the Highlands either by preagricultural or agricultural peoples'.¹

By 1966 it was known that the Highlands had been settled for at least 10,000 years and that very little of the excavated evidence referred to the later part of this period.² In this situation S. Bulmer modified her earlier system.³ Phase I remained the same. In Phase II, which dated from about 6,000 B.P., horticulture was adopted although hunting and food-gathering continued to be very important. Pigs may have been domestic if enough food was being grown to feed them. She stresses the development of local economic variations in this period. Axe-adzes and waisted blades were introduced, as were pestles and mortars at about 4,000 B.P. or later.

Phase III was restricted to the sweet potato gardeners and pig-raisers who occupied the Highlands when the Europeans arrived. This Phase, which was not yet documented archaeologically, included only the period of 'socio-economic "revolution" which the adoption of the sweet potato implies'⁴ and may therefore be no more than a

¹ S. and R. Bulmer, 1964, p.74.

² S. Bulmer, 1964b.

³ S. Bulmer (1966), pp.156-8.

⁴ S. Bulmer (1966), p.158.

few hundred years old. This Phase is clearly based on Watson's theory, which I have discussed above.

Any attempt at 'culture-historical integration' on the basis of only two stratified sites is, as the Bulmers recognize, liable to be premature, although I consider their construct was a necessary and useful one at that time.

It seems to me that now, however, these Phases need to be considerably modified in the light of further evidence, if not abandoned altogether. It will already be apparent, for instance, that polished axes are no longer a phase-marker in the Highlands so that the basis of Phase II (1964) is doubtful, while Phase III (1966) must be re-considered in the light of the evidence from the Manton site. In any reconsideration the following points also need to be remembered.

1. The number of artefacts on which parts of the Bulmers' constructs are based is exceptionally small. The primacy of the lenticular over the planilateral axe-adze is argued on one definite (but undated) and one dated (but only probable) example in a total of eleven pieces, while only three waisted blades have been found in dated contexts. The possibility that the chances of excavation may account for part of the pattern must be taken more into account in this situation.

2. S. Bulmer considers that the proportion of waste flakes is sufficiently high at both Kiowa and Yuku to show that tools were normally made on the site,¹ and that Kiowa,

¹ S. Bulmer (1966), p.143.

at least, was used for the same purposes throughout its history.

The figures are:¹

	Retouched tools	Utilised flakes	Waste flakes	Tool: waste:: 1:
Kiowa C	115	35	226	1.5
Kiowa B	70	25	136	1.4
Kiowa A	202	106	849	2.8
Yuku C	14	2	51	3.2
Yuku B (incl. crevice)	92	60	666	4.4
Yuku A ²	2	-	30	15.0
Yuku A ¹	8	8	17	1.1

The tool:waste ratio is quite unusual for a workshop site and therefore the claim that it is one must be doubted. In addition, one must also consider that the waste flakes are very large; at Kiowa they range in size from 0.4 to 3.0 inches (median lengths 0.8-1.2 inches)² and for Yuku the range is 0.3 to 2.7 inches (medians 0.7-1.5 inches).³ From these figures it appears that no waste material smaller than 1 cm. long was recovered from either site. This is an unusual situation⁴ and it may be

¹ S. Bulmer (1966), pp.108a and 129a.

² S. Bulmer (1966), pp.96-108. This information is not given for levels 4, 6 and 7.

³ S. Bulmer (1966), pp.118-28.

⁴ Cf. the evidence from Kafiavana and Batari.

suggested that the excavation procedures, which have not been described, were insufficiently precise to recover the smaller material. There is no evidence for or against this suggestion at present, but it does seem that this evidence should not be used to argue that Kiowa site was continuously inhabited for the same purposes throughout its history.

* * * * *

Before I suggest a construct for Highlands prehistory, I wish to summarise some of the more important results of the excavations reported here and then discuss briefly several more general problems.

The two sites in the Lamari valley - Batari (Fig. 11.3) and Aibura (Fig. 11.4) - provide an overlapping record from about 8000 B.P. to the present. Flaked stone and bone tools were made from the start of occupation. The stone tools show some degree of regional similarity and continuity throughout the whole period. Lenticular and planilateral ground stone axe-adzes may have occurred from about 3000 B.P., but small grooved and ground stone and shell artefacts, marine shell and pigs are definitely dated only to about 2000 years ago. Ceramics and perhaps fowls were introduced some 800 years ago, while dogs were found only in the most recent level. Waisted blades, pebble tools and tools with use polish are absent from the deposits at both sites. This absence may be due simply to sampling error but, since both sites present a similar picture, it may reflect the general cultural pattern of the area.

The faunal evidence suggests that much of the conversion of forest to grassland, at least around Aibura, occurred during the last 1000 years. It is within this period also that at Aibura fewer implements were retouched and more were simply used: this change is not found at Batari, where occupation ceases around 800 years ago.

The evidence from Kafiavana, the Asaro valley site with its 4 metres of deposit, will be important in any future construct of Highlands prehistory. The site was first occupied at least 10,000 years ago by people who ground stone axe-adzes, flaked pebble tools and 'scrapers', and produced use-polish on a few tools. They very soon began to receive marine shells. They appear never to have had waisted blades, and before very long they stopped making more than the occasional pebble tool. Small retouched tools were made in some quantity for about 5500 years: they show only slight and gradual changes over this time.

The first pig bones appear at Kafiavana some 5-6000 years ago and axe-stone was obtained from Kafetu quarry slightly later. About 4500 B.P. Kafiavana was apparently abandoned, but we do not know for how long. It was possibly re-occupied only around 1000 B.P., for retouched tools were rarer and flaked tools were generally smaller after the re-occupation and this is similar to the change which occurred at Aibura at this date. Occasional pieces of obsidian were used in this recent period. Pigs became commoner too, but no dog remains were ever left around the site. It is likely that the topmost levels of Kafiavana were deposited within the last hundred years.

The sequence at Niobe, adjacent to Kiowa, shows some similarities with S. Bulmer's site and differs in several ways from sites to the east. Many pebble tools occurred throughout the deposit, along with flaked stone and bone tools. Two waisted blades were found in the lower level and fossil shark vertebrae were used then, possibly for decoration. Ground stone axe-adzes, thin axe-like blades, bone awls and a mortar fragment occurred in the upper level. Pigs were found in the top of the site only, while dog remains were not found.

If it is assumed that the distribution of artefacts in the excavation represents the real picture reasonably accurately, then a comparison with Kiowa sequence suggests it was occupied from at least 6-7000 B.P. It was probably used until quite recently although the absence of large numbers of utilised pieces may suggest that it was not used for activities requiring flaked stone tools after ca. 1000 B.P. Such an argument assumes, of course, that a partial abandonment of retouched tools occurs west of the Asaro-Chimbu divide as well as east of it.

It will be obvious from this summary that the archaeological evidence is still extremely limited. In addition, the interpretations which can be given to some of the artefactual evidence need to be carefully considered.

1. Waisted blades seem to precede ground axes at the sites of Yuku and Niobe, and the two implements are contemporary for a thousand years or more at Kiowa. After about 4000 B.P., but before the present, the manufacture of waisted blades ceases in the Western Highlands. This may suggest that waisted blades are the initial axe-like

tool west of the Asaro, and are replaced by ground stone axes in this area only around 6-3000 B.P. Further, the presence of ground axes at Kafivava from the first settlement on, together with the general absence of waisted blades from the Eastern Highlands, suggests that the artefactual history of the two areas may be rather different throughout the early period.

The position of Kosipe in such a construct is not clear. It may be that in the Papuan Highlands both traditions are current, or that the site falls within the period 6-3000 B.P. The latter case would mean that the youngest possible date for this site is actually correct.

Any assessment of these ideas will depend largely on obtaining further dated examples of these tools. But it will also depend on an assessment of their function.

S. and R. Bulmer have suggested that waisted blades were axes or hoes, with the later, ground-edge examples being used for woodworking;¹ S. Bulmer has also seen them as generalised implements 'for digging wild roots and for rough clearing'.²

If waisted blades and ground stone axe-adzes were largely contemporary then the suggestion of hoes seems technologically more appropriate, but one wonders in this case why none have been recorded in contemporary use. Moreover, none of the prehistoric specimens have been recorded in an unquestionably horticultural context.

¹ S. and R. Bulmer, 1964, pp.64-6.

² S. Bulmer (1966), p.136.

More importantly, none were found at the Manton site whereas axes, which would seem to be less directly related to horticulture, were common there. This site is, of course, in an area of the Highlands where these blades might most likely be expected.¹

The waisted blade is probably best thought of as a generalised tool, used for many things by food collectors and gatherers. If the arguments about dating are sound, then this tool remained in use for some considerable time after the adoption of the ground axe-adze, which was certainly more difficult to make. One may thus agree with S. Bulmer who suggests that the ground edge on some examples of waisted blades may come from copying axes,² while, by suggesting that they had a generalised use in hunter-gatherer contexts, providing a satisfactory explanation both of the use-wear on many examples, and their absence in recent times.

2. S. and R. Bulmer suggest that the mortar and pestle complex of artefacts entered the Highlands from the north and northeast, probably as part of the sophisticated stone technology of an agricultural, originally sea-faring people.³ The other items in this postulated complex include figurines, perforated club heads and small perforated stones.⁴ It seems probable that these

¹ The numbers from excavations are: Yuku 23; Kiowa 3, Niobe 2, Kafavava 0, Aibura and Batari 0.

² S. Bulmer (1966), p.153.

³ S. and R. Bulmer, 1964, pp.71-2.

⁴ S. and R. Bulmer, 1964, pp.68-9.

artefacts have an extra-Highlands origin since similar types are found widely in Melanesia and it would be unusual to explain this by referring to a migration out from the Highlands.¹ It must be stressed that these artefacts have no context or date outside the Highlands.² They do not seem to be associated for instance with the Lapita-style pottery which occurs in eastern Melanesia at 2500 B.P. or earlier;³ they may, of course, be much older than this.

In the Central Highlands only one mortar fragment - from Niobe - has been found in an archaeological context and this may simply record re-use of the object, such as is common today.⁴

In addition, club-heads or perforated stones have been found at Aibura. This site is well away from the main concentration of mortars and pestles and is close to the 'Kukukuku' area where stone club-heads were made until recently.⁵ There is nothing similar to these objects in

¹ But see Riesenfeld, 1950, pp.641-5; A. Riesenfeld, 'On the Relationship between the "Mt. Hagen" and "Massim" axes of New Guinea' in J. Haekel, A. Hohenwart-Gerlachstein and A. Slawik (eds), The Vienna School of Ethnology, 1956, pp.473-5.

² E.g. Riesenfeld, 1956, p.475; J.C. Goodale, 'Imlohe and the mysteries of the Passismanua (Southwest New Britain)', Expedition, 8(3), 1966, pp.20-31.

³ Dates from New Caledonia are M336, 2435 ± 400 B.P. and M341, 2800 ± 350 B.P.

⁴ Berndt, 1954.

⁵ Blackwood, 1950, pp.34-6.

sites further west, although many examples have been collected from this area. It might be argued that even if the complex entered the Highlands as a unit, present evidence suggests that different parts of it were important in different areas, and that in the Eastern Highlands the club-head aspect persisted until modern times. There is, however, almost no prehistoric evidence of the existence of a mortar-and-pestle complex or of its dating or cultural association.

Quite apart from the problems relating to particular artefacts, it must be remembered that there is almost no diachronic evidence from lowland New Guinea or island Melanesia with which to make comparisons. Apart from the Aitape skull,¹ the nearest dated stratified site to the Highlands is found on Watom Island, off eastern New Britain.² There is also the undated and badly described site of Dudumunir, on the Mac-Cluer Gulf in West Irian³ and the undated but probably late sites found by my own and other surveys.⁴ Other well-dated sites are known from Borneo, the Philippines, New Caledonia, New Hebrides and Cape York, but all these are far distant from the Highlands. Sites are also known from Indonesia, but these have not been dated or well described so far, and their

¹ Hossfeld, 1965.

² The dates have not yet been published. See Specht, n.d.

³ W.G. Solheim II, Review of J. Roder, 'Felsbilder und Vorgeschichte des MacCluer-Golfes, West-Neuguinea', in Journal of the Polynesian Society, 71, 1962, pp.127-9.

⁴ See Chapter 2.

relevance to the Highlands is not yet clear.¹ Thus even if the extra-Highlands origin is suggested for some items, there is no evidence against which to check the theory. A final consideration is that the introduction of different items, even of the same complex, into the Highlands may have occurred piecemeal, for several routes of entry are known and all may have been used at different times and for different things.

* * * * *

In addition to these particular points two more general problems must also be considered.

1. It has been generally assumed that the first occupants of the Highlands were hunter-gatherers and at some later time either horticulturalists migrated into the area and hunter-gatherers became horticulturalists by acculturation, or else the original inhabitants gradually adopted horticulture under influences from outside the Highlands. While this is a reasonable theory there is no unambiguous evidence in its favour, since we do not yet know what the artefactual markers of horticulture are. S. Bulmer considers the polished stone axe-adze 'is only a pre-condition of large scale gardening and forest clearing and could easily be used in a hunting and collecting context',² and agrees that there are no absolutely definite markers. It has also been argued that the

¹ Heekeren, 1957, pp.86-108.

² S. Bulmer (1966), p.152. Hunter-gatherer Australian aborigines of course used ground stone axes.

presence of pigs, which must be fed if they are to be kept tame, is a good indication of some gardening by their owners.¹ As Bulmer recognizes however, the earliest Highlands pigs could be feral, and there is nothing directly to link them with agriculture at any stage. Any construct which is made must recognize this problem, even if only as the background to a theory.

2. The kinds of indestructible material which remain in rockshelters after different sorts of occupation,² and the degree to which this material represents both the particular activity and, more generally, the material culture of the people concerned, is a major problem in its own right.³ On theoretical grounds it seems likely that in the Highlands, for instance, the archaeological evidence now available should provide qualitatively different data from different periods, since a 'neolithic revolution' may have occurred during the period of occupation.

In this area there are only two open sites (Kosipe and the Manton site) known now. Neither of these is definitely a living site, while present-day peoples use rockshelters mostly during gardening, hunting, travelling or as refuges in times of conflict and actually live

¹ S. Bulmer (1966), p.152.

² Some assumptions about this have been made by L.R. and S.R. Binford, 1966, pp.268-70.

³ See e.g. S. Piggott, Approach to Archaeology, 1959, p.8; D.F. Thomson, 'The Seasonal Factor in Human Culture, illustrated from the life of a Contemporary Nomadic Group', Proceedings of the Prehistoric Society, n.s., V, 1939, pp.209-10.

elsewhere nearly all of the time. It could be argued from this that remains resulting from most of the times when horticulturalists use shelters are likely to represent only a few specialized activities, and it is only in unusual circumstances that the remains will represent the full range of material culture.

By contrast, it might be expected that earlier occupation levels, if deposited by hunter-gatherers, would present a wider picture of man's artefacts and activities. This is because hunter-gatherers often actually live in rockshelters and caves¹ whereas horticulturalists rarely do. Furthermore, hunter-gatherers generally seem to carry many of their possessions with them as they roam about the country, so that the chances of a wide range of objects being left in shelters are higher with these people than they are with horticulturalists.

Any attempt to apply this theoretical contrast in the use of rockshelters to the Highlands, however, is currently vitiated by two problems arising out of the available archaeological data. These are:

¹ Records of the use of rockshelters by hunter-gatherers are quite sparse. See however C.G. Seligmann and B.Z. Seligmann, The Veddas, 1911, pp.80-7; G.W. Stow, The Native Races of South Africa, 1905, p.33; B. Spencer, Wanderings in Wild Australia, 1928, vol. ii, pp.823-4 records that shelters near Oempelli were used at night in the dry season and for living in the wet season. See also B. Spencer, Native Tribes of the Northern Territory of Australia, 1914, pp.31-2 for a more detailed description of the use of shelters for sleeping.

i) we do not yet know which (if any) levels of the shelters relate to hunter-gatherers' occupations, so that the contrast in this area cannot be put into concrete terms.

ii) the degree of contrast between early and late levels in the sites is not great, and indeed a somewhat greater range of material comes from the later levels (Aibura Horizon I, Kafiavana Horizons I-II, Omkombogo?). This presumably indicates better preservation of more recent material: but it may also suggest that the activities which leave the majority of preserved remains were in fact carried on in rockshelters throughout the entire period. These activities presumably included the preparation of hunting gear and the processing of some plant and animal food. A closer study of the uses of different prehistoric tools is however needed before detailed interpretations of this kind can be made.

* * * * *

The general sequence of Highland prehistory which seems to agree best with the evidence available now is, with the qualifications discussed above, as follows:

About 11,000 B.P. small groups of people, probably hunters and gatherers, moved into the Highlands. Probably they lived mostly in the main valleys, where it was warmer, though they would hunt in the higher altitude forests. They were equipped with pebble tools and flaked tools and bone artefacts. They presumably made wooden artefacts, including bows and arrows, with stone tools, and processed vegetable matter in various ways. Trade for the valuable coastal shells probably went on from the

beginning and these together with red ochre were used for decoration. As time went on they exterminated some of the rarer fauna, including the local predator, Thylacine.¹

There is some suggestion that the tool-kits of the first Highlanders were different in different regions. In the Asaro valley ground stone axe-adzes were made; in the Chuave area and further west waisted blades and 'bifaces' may have been used instead, although more evidence is needed to prove this. The idea of some technological break between Eastern and Western Highlands is however reinforced by the early abandonment of pebble tools as a major tool type in the east. There may also be differences in the flaked tools, but this has not been shown.

In the Papuan Highlands, mortars may have been used along with waisted blades at this early stage, but whether this was true in the Central Highlands is unknown.

The first economic change seen in the archaeological record is the presence of pig around 6000 B.P. On available evidence its arrival had no technological correlates and, until the economic status of the animal is known, the economic and social changes its arrival may have caused cannot be assessed.

After the initial settlement of the Highlands no major artefactual change can be seen for some considerable time. Unless waisted blades came into use well after 10,000 B.P. (as the evidence from Kiowa suggests) there is

¹ H.M. Van Deusen, 'First New Guinea Record of Thylacinus', Journal of Mammalogy, 44, 1963, pp.279-80.

only a slight and gradual change in the retouched tools until at least 4000 B.P. There were few additions to the tool-kit either, although the planilateral axe-adze seems to have developed before 5000 B.P. The number of dated examples is very small so far.

It is at and after this date that some major changes in the use of rockshelters occurred. Kafiavana was abandoned for some time and people began to use Aibura. Kiowa was finally abandoned some time later. Only Batari continued in normal use. In the light of traditional dates for horticulture in South East Asia¹ it is at around this time that one might begin to look for the beginnings of horticulture in the Highlands. Whether the changes in shelter use do in fact relate to horticulture is unknown, for there is no definite archaeological referent for horticulture in the Highlands yet. If horticulture occurred at this time it is possible that mortars and pestles were introduced subsequent to this economic change. The younger dates from Kosipe would permit this, while the general absence of these artefacts from shelter deposits is consistent with a use in open ?village sites, although their place within any cultural context is still undetermined.

Horticulture, using complex methods, was definitely established in at least one main valley by 2500 B.P. or earlier. It is likely that both horticultural methods and implements such as paddle-shaped wooden spades² were

¹ Chang and Stuiver, 1966, p.540.

²

See J. Barrau, Subsistence Agriculture in Melanesia, 1955, p.14 and illustration.

introduced from outside the Highlands, but there is no evidence as to how these were adopted. It may have been a long slow process with people continuing to rely on hunting and gathering for a number of generations. Or it may have been a fairly swift economic change associated with the arrival of some new artefacts - something which one could call a 'neolithic revolution'. The current archaeological evidence supports neither case, nor is the evidence from other disciplines which bears on this question as definite as has sometimes been assumed. The change probably occurred in different ways and different times throughout the Highlands. The adoption of horticulture presumably allowed a general increase in population density with increasing pressure on the forests, leading to the formation of grasslands in ecologically less favourable areas. In the Eastern Highlands, at least, the faunal evidence suggests that this process had not greatly advanced by ca. 900 B.P.; although if this was so then the subsequent rate of conversion of forest to grassland must have been very high.¹ At both Aibura and Kafiavana fewer retouched tools and more unretouched pieces were found in the period

¹ Alternative or additional explanations include (1) although the conversion to grassland was considerably advanced by this time, it was only at this time, as the forest boundaries retreated, that people started to forego the forest as their major hunting ground; (2) for Aibura at least the relatively low intensity of occupation prior to 700 B.P. may well mask the early part of the changeover. Note also that although Aibura and Batari are in the same valley the spread of grasslands may have been somewhat different around the two sites.

starting at least 1000, and maybe 4000, years ago. It is possible that this change is gradual rather than sudden and that the process may have been accelerated by the arrival of European tools. The archaeological evidence is not precise enough to allow this to be determined, and the meaning of this change is also elusive. Some pottery began to reach the Eastern Highlands within the last 1000 years.

The most recent prehistoric changes probably occurred less than 300 years ago with the arrival of the sweet potato. This new addition to the crops would have been easily adopted into a horticultural system already based on root crops, especially as it allowed occupation to extend higher up the valley slopes. The social and demographic effects of this adoption are much less clear, but were probably not very marked.

Perhaps the most surprising absence from the archaeological record is that of dog, which has been found only in the most recent levels at any site. This absence may not be a real one of course, and it might be suggested that the important part played by dogs in some Highlands cultures has something to do with their absence from rockshelter sites.¹ Nevertheless, the dog has been found in Polynesia, for instance, from the time of the earliest settlement and it is associated there with pigs.²

¹ R. Bulmer, 'Why is the Cassowary not a Bird? A Problem of zoological taxonomy among the Karam of the New Guinea Highlands', Man, n.s., 2, 1967, p.19.

² R.C. Suggs, 'The Archaeology of Nuku Hiva, Marquesas Islands, French Polynesia', American Museum of Natural History, Anthropological Papers, 49, (1), 1961, p.195.

There seems no reason then not to expect dogs in the Highlands for at least the last thousand years, or perhaps for as long as pigs.

Summary

The dominating impression produced by a collection of Highlands stone and bone implements is one of sameness and continuity. In spite of slight changes the bulk of the tool-kit is the same from Aibura to Baiyer River and, apparently, Nipa in the Southern Highlands.¹ It is also very similar from 9000 B.C. to the present. This perhaps points out only that some basic aspects of life in the Highlands continued unaltered by other economic or technological changes.² I think, however, that it also points to a stability and continuity in Highlands technology not often found in post-Pleistocene prehistory. Even within Australia, presumably as isolated from other cultural influences as the Highlands, there were far greater technological changes.³ This continuity in the Highlands suggests, most importantly, that it may be legitimate to apply ethnographic information about stone tools to the analysis of archaeological materials from the

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H.K. Bartlett, 'Note on Flint Implements found near Nipa, Central Papuan Highlands', Records of the South Australian Museum, 14, 1964, pp.669-73.

²

This could be supported by showing that stone tools were in fact used for similar activities throughout the period. For some speculations on this see S. Bulmer (1966), pp.144-9.

³

D.J. Mulvaney, 'The Prehistory of the Australian Aborigine', Scientific American, 214, 1966, pp.84-93.

whole period - so far as it is now known - of human occupation. If this is indeed so, then an analytical tool of some power is available for this area. This thesis is a tentative attempt to use this tool.

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APPENDIX 2.1

DETAILS OF THE ARCHAEOLOGICAL SURVEY1. Sogeri1) Descriptive list of paintings and engravingsRamadordo¹

This site is formed by a large agglomerate block, its downhill face tilted at 20° to the vertical, sheltering an area of 8 x 2 m. The dry floor slopes slightly downhill. The shelter faces North 15° West. Engravings are found on the lower 1.8 m. of the block, which is composed of tuff. The engravings extend slightly below present ground level. Some have been partly removed by exfoliation of the stone.

The designs are: 23 examples of a), with line or dot, 6 painted or partly painted.

: 6 of a), without line or dot.

: 2 ovals similar to a) but with a horizontal line at the centre.

: One oval 13 cm. wide and 10 cm. high with a central dot. From the circumference of the oval radiate 18 lines all ca. 4 cm. long. The whole engraved portion is painted red and looks like a sun. A

¹ White and White, 1964, Fig. 2.

red and white painted design similar to this one has been recorded from Ifa Kuruku.¹

One engraved figure could possibly be interpreted as a stylised face. There are also a large number of engraved lines, forming no clear pattern.

No examples of design b) are present.

Ver 1

A large overhang with a sheltered area of 18 x 3 m., facing East 25° South. Because of the slope of the hill rain water runs in over the whole floor. The engravings are overgrown with lichen. All the engravings are of design a), and none are coloured. A variant form consisting of a rectangle with a line placed vertically was found. Two of the engravings were very large, being about 20 cm. long.

Vefai²

This shallow shelter is formed by the erosion of a tuff band for 55 m. along the foot of a ca. 30 m. high agglomerate cliff. The shelter faces East and Northeast. An area of about 12 x 2 m. above the shelter proper is covered with engravings. There are a number of examples of design a), but none of design b). Peculiar to this site are rows of pecked dots, spaced about 5 cm. apart. Each row may be up to 3 m. long and there are about 12 rows.

¹ Williams, 1931, Plate XI and Fig. 2b.

² See Kleckham, 1966.

Sakurukuru¹

This is formed by an agglomerate boulder from which a horizontal tuff band about 3 m. thick has been partially eroded forming a shelter 4.5 x 3 m. The floor of the shelter is only about 2.5 m. above the Laloki R. and contains no deposit apart from recent fires.

A total of 84 engravings were counted. Both designs are present, with design a) being much more common. Eighty-one of the engravings are painted red, and in two of these traces of white paint could be seen under the red.

In addition there is one red painting, rather like a centipede.

Moka

This 5 x 2.5 m. shelter is formed by the concave under-surface of an agglomerate boulder. Present headroom is ca. 0.75 m. On the south side of this boulder, about 1.5 m. above ground level is a small overhang, where there are a few faded red paintings. No clear designs could be distinguished, but one might be a human or animal figure. The stylistic affinities seem to be with the paintings of Yoi.

Ifa Kuruku

At this site, already partly recorded,² my wife and I traced some of the painted designs not figured, except in

¹ See Kleckham, 1966.

² Williams, 1931, pp.125-6.

a general picture, before. We also took a complete photographic record of the engravings, and a series of colour photographs of the paintings.

a) Engravings


Design a): 19 with dot.

8 without dot.

A variant on this is a vertical rectangle, of which three were found. In two cases these have a line down the centre.

Design b): 2 with dot.

22 without dot.

There are also five W's closed at the top, with a dot outside the design, between the two short arms of the W, thus .

In addition there is: 1 V shape; 1 six-pointed star; 1 solid, pecked circle; 1 irregular oval with a small U-nick at the top; 1 horizontal rectangle with inside it an inverted U, the arms of which rest on the lower side of the rectangle; 1 inverted U with three vertical lines inside the top half, and, finally, a number of engraved lines and dots.

We have been unable to detect any groupings among the engravings. They lie in a band about 60 cm. wide which runs along just above the main floor of the shelter. This band is inclined at about 30° to the horizontal.

b) Paintings

Above the band of engravings the shelter slopes almost vertically upwards for about 1 m. and then begins to slope outwards towards the lip of the overhang. It is

on the vertical part and for about 40 cm. up the overhang that the paintings occur. There are a large number of paintings stretching over a distance of about 8 m.

We had time to make tracings of only some of the paintings, among which are many superpositions.

Wakuia Wai

a) Engravings (Plates 2-1, 2-2)

The engravings of this site consist largely of the same symbols as at the other sites in the area.¹ Design

b) is not present.

The forms of engraving present are:

- design a) with bar 40
- with dot 17
- with bar and dot 2
- without bar or dot 3.

There are also 2 patterns of two concentric circles

- 1 circle with a cross inside it
- 1 figure of radiate lines and dots
- 2 'nest of Us'
- 1 possibly human figure with an asymmetrical surround
- 1 human figure with exaggerated sexual characteristics
- 5 areas of scratched patterns of lines and circles.

¹ Williams, 1931, pp.127-9.

b) Paintings

The paintings at this site have been recorded by Williams, and we did not find any others.

2) Test ExcavationsIfa Kuruku

This 60 m. long shelter lies about 15 m. above the Laloki R., and runs from east to west at right angles to the river. The eastern end lies directly above the left bank of the river. The paintings occupy about 12 m. of the eastern end, and the shelter here is simply a 1.3-2 m. wide concavity, about 3 m. high, with vertical agglomerate cliff above and below. The remaining 48 m. is filled with soil to within 60-100 cm. of the roof. The width sheltered is about 2.5 m. Two trenches were dug in this shelter.

Trench 1. This was dug about 18 m. from the western end. It measured 4 x 1.3 m. and was taken to a depth of 2.0 m. About 1 m. of the trench was dug under shelter, about 1 m. under the wide dripline and about 2 m. outside the shelter down the talus slope. After the initial dark, stony humus, about 10 cm. deep, the soil became very red (Munsell 5YR 4/6), slightly acid (pH 5) and almost stone-free. At a depth of 60 cm. in the sheltered part of the trench one small (23 x 12 mm.) mechanically struck flake was found. Carbon occurs in a finely divided form, scattered through the deposit. There were no other traces of human activity.

Trench 2. This 3.3 x 1.3 m. trench was dug at the eastern end of the shelter proper, at the point where it

ceased to be filled with soil. The trench was thus dug outside the shelter with one end of it against the agglomerate just below the base of the tuff band which formed the shelter. Apart from some surface humus at the outer end of the trench, the soil was a yellow-red (Munsell 2.5YR 5/6) mixed with decomposing agglomerate. It became more red towards the base of the trench. This trench was abandoned at 1.3 m. depth, when it became clear that no traces of human activity were present.

Koba

This 7 x 8 m. rock shelter is formed by a large agglomerate boulder supported at the sides by other boulders and having the south end resting against the hill slope. The height of the shelter at the front is 2 m. On the east side the front 3 m. of floor is flat with some rocks protruding, whilst behind this there is a steep slope up to the cave roof a further 2.6 m. back. In the west half the first 2.6 m. of floor is mostly covered by large boulders. An extremely large block about 3.3 m. high then forms a step to a shelf which continues with about 60 cm. clearance to the back of the shelter. This shelf is composed mostly of rocks with dry soil filling the interstices between them. The discovery of a ground axe and some sherds on the shelf suggested that this site might repay excavation. So much of the shelter was occupied by irremovable boulders that 'excavation' was restricted to removing the soil between them.

A trench (1.3 x 1.3 m.) was excavated in the front of the shelter on the eastern side. At a depth of 30 cm. water was struck which was probably a relic of heavy rain the previous evening, and the trench was abandoned. A few sherds and a hammer stone were found.

Next an attempt was made to remove some smaller boulders and soil from the eastern back slope, towards the centre of the shelter. A face just over 2 m. high was created, including about 45 cm. excavated from below floor level. The soil removed had apparently washed or slumped in from the rear of the shelter, and it contained 3 axes, 3 axe fragments, 1 bark-cloth beater, sherds and bone.

Some soil was removed from the western back shelf and the finds collected. These included two ground axes, two flaked axes, sherds, bone, shell and nut-shells.

A small trench (Trench 2) was dug at the foot of the large boulder at the western front of the shelter. The soil was very wet and this trench soon filled with water.

None of the finds can be shown to be in association and nowhere was there any evidence of stratigraphy. We think that most of the finds became incorporated into the deposit by being placed at the back of the shelter and then being covered by hillwash.

Table A2.1 (p.ix) sets out the finds made.

It is interesting to note that of the six candle-nut (Aleurites) shells, three are split laterally while three appear to be opened by biting off one end. We were told by local people that these nuts were eaten, and that they have purgative qualities. They claimed that the nuts were opened by biting although the horny skin is very hard.

Table A2.1 : Koba, excavated material

	Trench 1	Trench 2	West shelf	East hillwash
Ground axes	-	-	2	1 (cutting edge only)
Partly ground axes	-	-	-	2
Ground axe frags	-	-	-	3
Flaked axes	-	-	2	-
Pink ochre	-	1 piece	56 gm	-
Bark cloth beater	-	-	-	1
Rubbing stones	2?	-	1?	-
Hammer stone	1	-	-	-
Sherds: undecor.	5	15	16	61
: decor.	3	-	1	1
: painted	-	-	2	1
Nut shells	-	8 ¹	1 ¹	4
Shell	-	-	10 ³	2 ³
Bone	-	-	-	5 ²

¹ Mr R. Pullen, Herbarium of the Division of Land Research, C.S.I.R.O., identifies these as 2 probl. Terminalia kaernbachii, 1 another terminalia species, 6 mesocarps probl. Aleurites moluccana (Linn.).

² Fig: 1 metapodial, length 86 mm.
 2 gnawed frags of scapula.
 1 frag. tibia.
 2 unidentifiable pieces.

³ Identified by Mrs H. Zandorff and Mrs E. Harris:

(continued p.x)

Table A2.1 (continued from p.ix)

<u>West shelf:</u>	frags	common oyster
	2 frags	red mouthed stromb (<u>Conomurex lukuanus</u>)
	1 "	northern thorny oyster (<u>Spondylas ducalis</u>)
	1 "	ark shell (<u>Anadara scapha maculosa</u> [Reeve])
	1 "	smooth spider shell (<u>Lambis lambis</u>)
	4 "	tellen (variety undeterminable)
<u>East hillwash:</u>		
	1 "	tellen
	1 "	red mouthed stromb.

All sea shells must have been brought or traded from the coast eight or more miles away over the Astrolabe Ranges - a day's walk, according to the Koiari. The shells probably represent food, and were traded into the area until recently.

2. Collingwood Bay

Oreresan

Three small trenches were dug in this old village site, which lies mostly on the inland side of the old Wanigela mission. The site is a low irregular mound, at least 40 x 15 m., now greatly disturbed by pigs, gardening, house building and earlier mission activity. Surface finds include pottery, shell, bone and unretouched obsidian flakes and cores. Since the site is now partly covered by Oreresan village it is difficult to differentiate contemporary and old deposit.

Trench 1. 1.3 x 1.3 m. Dug to 60 cm. depth, when water flooded the bottom. Artefacts continue below this depth. The soil was wet and sandy, and no stratigraphy could be observed. Finds included pottery and obsidian, occasional bone fragments and some shell. The shell appeared to be decaying fairly rapidly.

a) Pottery

At a depth of 30 cm. two sherds with horizontally pierced triangular lug handles were found. These are quite unlike any contemporary pottery that I saw made or used, since this has neither handles nor shaped rims. At 60 cm. a sample of pottery was collected. Some of this

looked quite like modern pottery. My informants sorted this sample into 'modern' and 'olden' times; the criterion they used was thickness - if any part of a sherd was thicker than normal it was classed as old. Their sorting can be shown to be internally consistent : on 20 'old' and 23 'modern' sherds collected, the average thickness of the thinnest part of the sherd walls is 6.2 mm. and 4.8 mm. respectively. The ranges are 'old' 4-11 mm. and 'modern' 3-7 mm. It should be noted that many of the sherds called 'old' have a part of the sherd which is much thicker - average max. thickness 9.9 mm., range 7-15 mm. - while the 'modern' sherds do not vary much in thickness. The sherds are dull brick-red to dark grey in colour. The firing leaves variegated patches of colouring on the sherds, but the pots are sound. The paste is fairly coarse. Two of the sherds appear to be slipped, one with a red slip on the inside, the other with an all-over black slip. Decoration consists of smoothly incised lines in curvilinear patterns and fingernail impressions on some rims.

b) Obsidian

This, I was told, came from Goodenough Island, 60 miles east of Wanigela. Unretouched flakes were used as recently as 20-30 years ago for razors and knives. One multiplatform core and some small flakes were excavated at 60 cm. depth.

Trench 2. 1.3 x 1.3 x 0.5 m. The soil was sandy, dark grey when wet but lighter when dry (Munsell 5YR 6/1). This trench produced sherds, some bone (pig, macropod), shell and obsidian. Two fragments of polished axe, five unretouched and two retouched flakes of obsidian were also

found in the trench. At 50 cm. a carbon sample was recovered from the mud by washing it in sea water. With it was associated another possible axe fragment, some obsidian, and pottery like the 'modern' pottery of Trench 1.

Trench 3. 1.3 x 1.3 x 0.7 m. This trench was dug in a coconut grove and hence through a practically solid mass of roots. There was a concentration of shell in the top 15 cm., but it was found throughout, along with sherds, obsidian and pig bone. Among the sherds one had part of a flat base while others showed everted and rolled over rims. Modern pots from this area have rounded bases and a plain edge rather than a rim. Also it seemed to me that some of the decoration is not like that now applied to pottery made in this area, but this would need confirmation by a detailed ethnographic study.

Wanigela River

A small trench was dug in a village site about 1 mile south of Oreresan. This site rises 15-60 cm. above the surrounding mangrove swamps and lies about 300 metres from the mouth of the Wanigela R. on the north bank. I was told that this village was occupied when a mission was built there in 1895. Surface finds included pottery, and obsidian. These are found throughout the depth of the mound, along with shell and pig and dog bones. No stratification could be observed. Some of the sherds were described by my informants as being of 'olden times'. One sherd had a hole bored through it just under the rim. The hole was produced by a drilling action from both sides of the pot. I saw no contemporary pottery where this

technique had been employed. Some of the decorative motifs seem to differ from those used on modern pottery.

Rainu

Lying on the surface around Rainu village was a plentiful obsidian flake industry, probably modern. The industry comprises unretouched flakes, flakes with some sign of utilisation and cores. No retouched tools were found. One primary flake of diorite was found; local people said that they knew of no stone-working using this type of stone.

3. Miagolo

Miagolo III has a large, flat and dry entrance, 4 x 2.1 m., to the right of which there is a sloping narrow crack where a stream now enters the cave. The entrance gives directly onto a dry platform some 11 m. long, 8 m. broad and 2 m. high. On the right of this platform the floor drops sharply away to the bed of the stream which formed the cave. On the surface of the platform were traces of modern fires, as well as shells, bones and a few sherds.

Two test trenches were dug in the platform, one 2 m. from the dripline and the other 7.5 m. inside the cave. The first trench, 1 x 1 x 1.5 m. contained, apart from a superficial covering of ash and carbon, an unstratified, slightly acid clay (pH 5.5 at 15 cm., 6.5 at 45 cm.), yellow-brown in colour and becoming more clayey and damper as the depth increased. The clay was sterile except for occasional flecks of carbon in the top 60 cm.

Trench 2, 40 x 40 x 75 cm. was dug by torchlight. The stratigraphy revealed was (1) 7-10 cm. light grey ashy soil, very fine, some bone; (2) 0-7 cm. yellow-brown clay, sterile; (3) 38-45 cm. grey soil, very friable, containing considerable burnt bone, carbon and shell, but apparently unstratified. No artefacts were found. At a depth of 30 cm. the pH was 7.5 (slightly alkaline); (4) to base. Yellow-brown clay, sterile except for carbon flakes. At 75 cm. pH 8+ (alkaline).

No implements whatever were found in either trench.

Two main species of shells occur. Miagolo villagers said that at least one of these was brought into the area until quite recently.

The bone recovered consists of small fragments, most (if not all) of which seem to be of small animals such as bats or birds.

4. Tufi

Kobari

On the south side of Tufi fjord, opposite Rukupa hamlet. 8 x 7.5 x 4.5 m., this shelter faces North at an elevation of ca. 30 m. above sea level. Although it contained more than 60 cm. of soil no archaeological traces appeared either on the surface or in a test trench.

Forva

About 1½ miles up-river from the head of Tufi fjord. 8 x 6.5 x 4.2 m. high, this shelter had loose red-brown earth on the floor. Some modern charcoal and shell was

found on the surface; some sherds and shell were collected from a 30 cm. deep test trench. The trench showed no strata, the finds being loose in the soil. The shelter was used as a refuge by a village for some time in World War Two.

Baiya

About half a mile from the head of Maclaren Harbour, this shelter is on the north side of the Kofore River. 14 x 1 x 2 m., this low shelter at the foot of a scarp contains more than 80 cm. of deposit. Some pottery and shell was found in the top 30 cm., but no ash or strata occurred. The pottery may be modern. This site is only about 3 m. above the present river level, and appears to be flooded during some of the larger floods.

Kumiyawa

On the north side of Amuan fjord, this shelter lies about a quarter of a mile east of Amuan village. It is 14 x 4 x 2 m. high and contains more than 80 cm. soil. Occasional shells can be seen of the surface. A test trench produced one small piece of pottery with a bright red slip on the inside: slipped pottery is not known in the area now. No stratigraphy could be seen.

Kerefumat

On the south side of the village leading from the head of Tufi fjord, about 1/3 mile upstream from Tuarina hamlet. This shelter lies at an elevation of ca. 50 m., and measures 22 x 9 x 2 m. Surface finds included pottery, shell and an obsidian flake. A 1.3 x 1 m. test trench was

dug to a depth of 1.8 m., when bedrock was struck. A lens of shells and ash was found at 10-12 cm. depth, and occasional shells were seen down to a depth of 30 cm. The soil contained many angular rock fragments and ranged from slightly alkaline to neutral (surface pH 7.5; 30 cm. pH 6.5-7.0; 1.8 m. pH 6.0). No artefacts were found.

Note on Ora Bay pottery

I was given some sherds of pottery recovered while digging house foundations at Ora Bay, in Dyke Ackland Bay about 80 miles north west of Tufi. This pottery is unlike any now made in the area. I am informed that the site is on a rapidly eroding hill top, in 45-60 cm. of soil, and that there are no other signs of occupation than the sherds.

The pottery is grey or reddish in colour, and unslipped. Rims are everted, rolled over or stuck on. The decoration consists of impressed dots and lines, sometimes curvilinear.¹

5. Kainantu

1) Ramu R. headwaters

Ten caves were investigated but none showed much archaeological promise. They are listed here for the sake of future workers.

¹

This pottery is now being studied by Mr J. Specht.

Oi

About quarter of a mile from Saiora village this cave is a 12 m. long passage through a thin strike belt of limestone. An earth oven was seen on the floor and modern charcoal drawings (e.g. Ukelele)¹ on the walls. The top six inches were recent ash, the rest of the 80 cm. deposit was sterile.

Sonofi village

One rockshelter, Kukusabenote, contained no archaeological traces.

Several river caves were found very near the village. One of these, Tafora, contains a 6 x 5 m. ledge about 30 m. inside the entrance. On the surface of the ledge are 4 fireplaces and a timber bulwark. There is at least 25 cm. of ashy deposit. This cave was used as a refuge in 1946;² it is so dark that it would probably only ever be used in this way.

Norekori

Five burial niches in limestone contain modern skeletons and recent burials.

Yauna

Five underground rivers are known about a mile to the east of the Swiss Evangelical Mission. None contain any

¹ White and White, 1964, Fig. 14.

² F. Parker, Dept. of District Administration, pers. comm.

archaeological traces. The Mines Officer at Kainantu, Mr N. Stagg, reports that more promising caves occur further downstream.

2) Markham headwaters (Wanton R.)

Omompa

An underground river system about 3/4 mile from Kambira village. The upper of three entrances has a 6 x 4.5 m. sheltered shelf with some 20 cm. of deposit including two pieces of flaked chert.

Other caves are reported near Mt Victor goldmine but these could not be visited.

3) Lamari R. headwaters

Tibu'are

This cave lies about half a mile north of the junction of the Sorera and Lamari Rivers. It lies some 100 m. above the Lamari River and, being itself an old river system, is probably of some antiquity. A line of poles interspersed with brush has been erected across the entrance to catch flying foxes. Inside the cave runs for at least half a mile. A complex succession of alkaline to neutral soils, clays and muds was trenched to a depth of 2.4 m. One mechanically struck flake was recovered.

Isena

This lies about 50 m. below Tibu'are and belongs to the same system. A sheltered forepart of the cave was

occupied recently, but a trench 1.25 m. deep produced only a polished axe, 2 kg. of ochre and some scattered pieces of carbonised wood. On the wall are two negative handprints in red, said to be the mark of the tambaran (spirit) Sirebo.

Bari'ira

This small cave lies to the northwest of Batari. It contains no deposit. On the limestone cliff surrounding it are red and yellow paintings similar to those at Batari. They were not recorded in detail.¹

Asara

This large granite boulder is about three miles north of Tibu'are and one mile west of Asara village. On one face of it are several clear, if crude, red human figures. Over the head is a half-circle which, in the clearest figure, is joined to the skull with nine radiate lines. This may represent a head-dress or hairstyle. One figure shows one rather pedulous breast.

4) Old village sites

The only deserted village sites noted were those abandoned within the last two or three generations. Many old garden boundaries were visible as grass-marks, due to differential growth, especially around Norekori. Survey and excavation of this type of site is currently being

¹

Some are figured in White and White, 1964.

carried out by J.D. Cole for the University of Washington Microevolution Project.

6. Asaro valley

Only two sites were discovered in the Asaro valley although there are reports of caves from Henganofi (Dunantina R.), the upper Bena Bena R. area and around the Kami Thumb in the southern Asaro valley.

The two sites discovered are both rock shelters. One is Kafiavana near Kami, later excavated (see Ch. 7). The other, Namefa, is at the other end of the Asaro valley at Mirima, 12 miles northwest of Goroka. The site is one of several caves visible in the northeast face of a limestone cliff about $\frac{1}{2}$ mile from Mirima plantation on the west side of the Angga R. Nemeffa is a small high dissolution cavity with a floor area 9.5 x 3.3 m. An area of 6.5 x 3.3 m. at the front of the deposit has been dug away for fertiliser¹ to a depth of 1.5 m. In the section many hearths and bones, mostly bat bones, are visible. The site was probably mostly used for cooking.

7. Chimbu²

Aukombogo

On backslope of Poral Range about $2\frac{1}{2}$ miles upstream from Kwi-Chimbu junction, and 60 m. above river.

¹ Mr I. Downs M.H.A. has agreed to try to prevent further disturbance to this site.

² Many of these caves were discovered and drawn to my attention by the Goroka Speleological Society, whose generous help I wish to acknowledge.

An 18 x 9 m. shelter with steeply sloping floor. Soot on roof. Some ash levels visible in steps in floor.

Kokokombogo¹

On west side of Chimbu R. gorge overlooking Chimbu-Singga R. junction. Entrance to old river cave, much soot on roof. Some recent fires on surface but apparently little depth of deposit.

Numei Numbun kombogo

Small shelter (8.5 x 2 m.) at foot of cliff on west side of small tributary of Chimbu River. Tributary forms next valley north of Kwi River. About 130 m. above Chimbu R. Small test hole gave 1 step-flaked artefact, two flakes and food bone (at least 2 cuscus) in a dark brown undifferentiated soil which continues for at least 55 cm.

Ombondo kombogo

About 1/3 mile from Singga River on north bank, ca. 1 mile east of Pari resthouse. A small sloping overhang shelters an area of ca. 7 x 2 m. The shelter is fairly dry. An undifferentiated brown soil extends more than 40 cm. down. A small test pit produced 5 stone flakes and 1 utilised piece, and bone (incl. 2 macropods, 1 cuscus, 1 Pseudocheirops).

Kerang

About 2 miles up Diemanial Ck, a small tributary on the north side of the Kwi R. Altitude 6700 ft MSL. A

¹

Possibly Bulmer's site 65. S. Bulmer (1966), p.173.

small (5 x 4 m.) limestone overhang, very soot blackened. Deposit: 20 cm. fine grey ashy soil (1 cuscus mandible from test hole) underlain by sterile brown soil.

Wamé Drra kombogo ("Big Mouth" cave)

About 2 miles south of Gogme mission on the Gembogl Rd, west side of Chimbu R. About 60 m. above the road and clearly visible from it. Faces east, with a 12 m. high entrance to old river cave which slopes up about 8 m. in a distance of 30 m. and then goes into the hillside. Just inside the entrance is a flattish platform about 5 x 8 m. Roof is soot blackened and there is much vegetable matter on the surface. Deposit: ash and soils to a depth of >1 m., but only a little bone was recovered.

Local people say that swiftlets and bats are still caught here.

Keuw

A small limestone overhang about $1\frac{1}{2}$ miles up the Singga R. from the Gembogl road on the south side. Area 5 x 4 m., recent fires on surface. Wash in from both sides and probably no deposit.

Oran

On south side Singga R. about $\frac{3}{4}$ mile downstream from Gembogl Rd, directly opposite Pari resthouse. A 3 x 3 m. shelter above main Oran cave. More than 25 cm. of carboniferous soil, with some bone.

Kokombogo

In upper Kwi River valley, about 8 miles upstream from junction with Chimbu. Slanting shelter with several levels. About 200 m. above river on backslope of Poral Range. Test holes produced at least 30 cm. of deposit with large quantities of animal bones and a few flakes. No stratified hearths visible.

Korokombogo¹

This is the low entrance to a large cave system about 50-60 m. above the south bank of the Kwi R., about half a mile upstream from the Chimbu-Kwi junction. A 2 x 1 m. trench was excavated to a maximum depth of 80 cm., 2 m. inside the dripline. Four main layers were noted:

1. 20 cm. of red-brown (5YR 3/2) loam matted with roots.
2. 15-20 cm. of red-brown loam with patches of fine yellowish silt.
3. 15-20 cm. of fine silt with much wood ash and carbon. This tails out toward the entrance.
4. 20-30 cm. very hard red, nearly sterile soil.

A few animal bones were recovered from all levels, with pig being present throughout. The only artefact found was a broken axe from the talus slope under the dripline. It is made of hornfels and only the bevels are

¹

Reference number KRK64.

ground. The cross-section is planilateral with very flat faces and slightly rounded sides. The butt is squared off and blunt. The cutting edge is curved, beveled asymmetrically and forms a sharp corner with the sides. Length 10.4 cm.; max. width 4.8 cm.; max. th. 4.2 cm.

Mabic²

Mabic is the entrance to a very large cave system on the south bank of the Kwi about $1\frac{1}{4}$ miles above its junction with the Chimbu R. at an altitude of ca. 5100 ft MSL. A 4 x 1.5 m. trench was opened at one entrance. It showed about 15 cm. of deposit, including much ash, lying on a sterile clayey silt. Twenty six postholes were recorded. Finds included pieces of glass and iron, 14 flakes of chert, 7 chips of ground stone and domestic and wild animal bones. The only axe-fragments sufficiently large for description were found on the surface.

1. A complete flaked axe made of green hornfels. The overall shape is rectangular with a square blade and butt, the faces are flat and the cross-section lenticular. Dimensions: 12.2 x 7 x 1.4 cm.

2. A ground butt of hornfels. Sufficient remains to show that the axe had biconvex faces and a squared-off side.

¹ This formed a demonstration and training excavation for some members of the Goroka Speleological Society. Reference number M64.

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APPENDIX 3.1

SOME COMMENTS ON THE ECOLOGY OF SOME HIGHLANDS MAMMALS

H.M. Van Deusen, Curator of the Archbold
Collections, American Museum of Natural
History, New York.

1. Macropodidae: Thylogale is the true grass wallaby of the Highlands. It is the maker of the 'pads' so frequently seen in the alpine and subalpine grasslands. It will evidently go as high as there is grass to eat. Greater weights may be reached but there is no data.

: Dorcopsulus is primarily a mid-mountain forest wallaby. It will feed out in grassland regularly, but never far from the forest. Dorcopsis, as Tate (1948, pp.285-90) states, is normally a rain forest, low elevation animal.

: Dendrolagus at higher elevations (e.g. Mt Kubor) may feed a good part of the time on the ground. This refers to D. matschiei and subspecies goodfellowi. The former may venture into grassland borders, but there is no proof of this. D. dorianus and probably ursinus are closely restricted to the forest. In good forest Dendrolagus may spend a lot less time on the ground.

2. Palangeridae: Phalanger orientalis is strictly arboreal and usually rain forest though it may also be found in the lower oak forest. Phalanger gymnotis is probably a ground forager. Both may occur in the excavated collections, as may Phalanger vestitus.

: Dactylopsila is primarily a rain forest animal. Dactylonax tends to replace Dactylopsila in the mid-mountain rain forests and many animals in Highlands sites may be expected to be Dactylonax.

: Petaurus breviceps. The mountain species is a small dark forest animal.

: Eudromicia. Present from about 4,000 feet to the peaks and as one goes higher it becomes more common. Aboreal, forest only. Common in the subalpine forest.

: Pseudocheirus. There is altitudinal zonation in this genus, but much more work remains to be done. Generally forbesi is lowest, then corinnae and finally cupreus, but there is a great deal of overlap. The first two are strictly forest but cupreus often seems to venture out of the forest to forage in the tussock grass at higher elevations. All these species occur in the Eastern Highlands.

3. Peramelidae : Peroryctes longicauda or Echymipera kalubu or E. clara may be present. The former is present from 3,500ft to the highest peaks, so that in the upper parts its habitat is grassland. This species becomes commoner at the higher altitudes. P. raffrayanus may take over the longicauda habitat in some areas (e.g. Huon Peninsula).

4. Dasypodidae : Satanellus is more often found in forest, but it will wander out into the grassland also.

: Antechinus is strictly a forest dweller.

5. Muridae : Hyomys is primarily a forest animal though it may go into grassland. It does not therefore compete much with Mallomys.

: Mallomys seems to be primarily a grassland animal though it may also forage in the forest.

: Uromys is primarily a ground-dwelling rain forest rodent, but it climbs very readily. When U. anak is present in the oak forest it is doubtful if U. caudimaculatus ranges above 2000-3000ft.

6. Tachyglossidae: Zaglossus appears to be quite strictly a forest dweller, and probably grows to a larger size than is given in the table.

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	Name	Habitat	Altitudinal Range	Weight (max.)
1	<u>Thylogale</u>	forest & grass	s.1* to 14,000'	14 lb. 8 oz.
2a	<u>Dorcopsulus</u>	forest & grass	2500'-9500'	6 lb. 8 oz.
2b	<u>Dorcopsis</u>	forest	s.1 to 1300'	6 lb. 6 oz.
3	<u>Dendrolagus</u>	forest & grass(?)	3000'-11,000'	18 lb. 8 oz..
4a	<u>Phalanger</u> <u>orientalis</u>	forest	s.1 to 4000'	6 lb. 4 oz.
4b	<u>Phalanger</u> <u>gymnotis</u>	forest	s.1 to 8000'	7 lb. 9 oz.
4c	<u>Phalanger</u> <u>vestitus</u>	forest	5000'-10,000'	7 lb. 2 oz.
5a	<u>Dactylopsila</u>	forest	s.1 to 5000'/6000'	1 lb. 2 oz.
5b	<u>Dactylonax</u>	forest	4000'-8000'	1 lb.
6a	<u>Petaurus</u> <u>breviceps</u> (lowland)	forest	s.1 to 3000'	4.7 oz.
6b	<u>Petaurus</u> <u>breviceps</u> (mountain)	forest	3000'-8000'	2.6 oz.
7	<u>Eudromicia</u>	forest	4500'-13,000'	1 oz.
8a	<u>Pseudocheirus</u> <u>forbesi</u>	forest	2000'-9000'	2 lb. 5 oz.
8b	<u>Pseudocheirus</u> <u>corinnae</u>	forest	4000'-9000'	2 lb. 8 oz.
8c	<u>Pseudocheirus</u> <u>cupreus</u>	forest & grass	5000'-13,000'	5 lb. 6 oz.
9a	<u>Peroryctes</u> <u>longicauda</u>	forest & grass	4000'-15,000'	1 lb.
9b	<u>Echymipera</u> <u>kalubu</u>	forest & 2 ^o grassland	s.1 to 5000'/6000'	3 lb.

*Sea level.

Name	Habitat	Altitudinal Range	Weight (max.)
9c <u>Peroryctes</u> <u>raffrayanus</u>	forest	1500'-12,000'	3 lb. 6 oz.
10 <u>Satanellus</u>	forest & grass	s.1 to 10,000'	2 lb. 1 oz.
11a <u>Antechinus</u> (sp. 1)	forest	s.1 to 5000'	1.7 oz.
11b <u>Antechinus</u> (sp. 2)	forest	6000'-10,000'	1.6 oz.
11c <u>Antechinus</u> (sp. 3)	forest	5000'-8000'	1.7 oz.
12 <u>Hyomys</u>	forest & grass (?)	4000'-10,000'	2 lb. 14 oz.
13 <u>Mallomys</u>	forest & grass	5000'-12,500'	4 lb.
14 <u>Uromys</u>	forest	s.1 to 6000'	1 lb. 9 oz.
15 <u>Zaglossus</u>	forest	4000'-9500'	16 lb.
16 <u>Dobsonia</u>	forest	s.1 to 6500'	1 lb. 4 oz. (aver. 1 lb.)

APPENDIX 3.2

SURVEY ANALYSIS PROGRAM

M. Rose, Computer Programmer of the
Research School of Social Sciences,
Australian National University.

The Survey Analysis Program is a general purpose program designed to produce one-way, two-way or three-way frequency tabulations from punched card data. The number of different tables which may be produced in a single run is a function of the size of the tables and the number of variables involved. The largest number of cards which can be analysed by the program is 99,999.

A set of data is the numerically coded information belonging to one 'case' and may consist of up to three data cards. The cards within the set must be sequentially numbered. A field or variable is any single piece of information and may occupy one, two or three columns, so that the maximum range permitted to any variable is 000 to 999. Each variable must be separately defined and there are options for editing the coding, for limited re-scaling and for determining ratios. Each table required must be separately defined and there is one master card which supplies general information.

There are options for Proportions, both of row and column totals, and for Chi-Square.

It is also possible to run any number of jobs using different sets of data in any one run, provided it does not exceed the time limit.

The program is stored within the A.N.U. computer but for any further information contact the Programmer, R.S.S.S.

APPENDIX 6.1

HUMAN SKELETAL REMAINS
FROM AIBURA CAVE, NEW GUINEA

Leonard Freedman, Department of Anatomy,
University of Sydney, Sydney¹

A total of 86 fragments of human skeletal remains were excavated from Aibura. Most of the material is badly damaged, eroded and very fragmentary, but there are 2 fairly large calvarial fragments, the right half of a palate, 4 loose teeth, most of 2 tibiae and several reasonably intact hand, foot and digital bones. Examination of the whole assemblage clearly indicates that the remains are from a number of different individuals, but, because of the nature and fragmentary condition of the specimens, the exact number (and also sex and race) are difficult to determine. Some of the fragments show signs of gnawing, probably by rodents, and a few may have been in or near fire.

Description of the individual specimens

The excavated material includes: (a) 35 fragments of skull bones (including 4 teeth), (b) 15 mostly very small pieces of bones from the axial skeleton (sternum,

¹ Present address: Dept. of Anthropology, University of Wisconsin, Madison, U.S.A.

vertebrae and sacrum) plus 2 small uncertain fragments, (c) 13 upper limb and (d) 21 lower limb bone fragments of varying size and condition. These specimens are all illustrated in Plates 1-8, to which references are made below in the description of the individual fragments.

(a) Skull

The skull fragments from Aibura include a number of specimens which show interesting features and more than one individual is clearly represented.

(1) 8 calvaria fragments: Plate 1:- Row A, group of 8 fragments on left. Numbers - A64/XV/(4), 7 fragments; A64/XV/(4), single fragment at bottom right of group. These 8 fragments are all yellowish in colour and come from various parts of the calvaria roof, probably of a single individual. The 1st and 4th fragments in the upper row join together, but the edges of the other fragments do not appear to articulate. The 1st upper and 2nd lower fragments show small portions of cranial sutures; the 3rd lower fragment shows a small blackened area consistent with charring. The 2nd upper fragment is about 3.5 mm. thick, the rest range from 6-8 mm.

(2) 8 calvaria fragments: Plate 1:- Row A, 2nd group of 8 fragments. Numbers - A64/IV/(7). Six of the fragments, numbers 1, 2 and 4 in the upper row and 1, 2 and 3 in the lower row, are very thick fragments (up to 1.7 mm.), mostly from the midline region of an occipital bone, plus a small portion of the adjacent parietal bone in specimen 1 of the lower row. These 6 fragments are all blackish in colour (possibly the result of slight charring) and almost certainly come from a single individual,

although they can not be joined together. Fragment 3 in the bottom row shows an articular edge, probably for the adjacent parietal bone. The parieto-occipital (lambdoid) suture on specimen 1 of the lower row is completely synostosed endocranially and almost obliterated ectocranially. The remaining 2 fragments, number 3 of the upper row and 4 of the lower row, are 5.7 mm. thick, i.e. rather thinner than the other six, and blackish-yellow in colour. These 2 fragments are articulating fragments of a parietal and an occipital bone and quite likely come from a different individual to the above 6 fragments.

(3) Calvaria roof fragment: Plate 1:- Row A, upper of last 2 fragments on right. Number - A64/VIII/(5). This is a small fragment with the inner table of bone missing and the outer showing signs of gnawing.

(4) ? Parietal fragment: Plate 1:- Row A, lower of last 2 fragments on right. Number - A64/VII/(5). This small fragment shows an articular edge and some grooving on the ectocranial surface. This fragment is probably a small portion of a parietal bone, from the region of articulation with the temporal bone just above the mastoid process.

(5) Left temporal fragment: Plate 1:- Row B, 1st specimen. Number - A64/IV/(5). This blackish-yellow specimen is considerably damaged and eroded. The mastoid process is partially broken but would not have been very large; the mastoid notch medial to it is very deep. The external acoustic meatus has lost its anterior wall. The small remaining postero-inferior portion of the squamous

part of the bone is thick (\pm 6 mm.) and a small blackened area present is possible evidence of charring.

(6) Right temporal squame: Plate 1:- Row B, 2nd specimen. Number - A64/IV/(5). This whitish specimen consists of the anterior part of the squame plus a small portion of the root of the zygomatic process. The bone is flat and thin and only a small sloping, central part of the articular surface for the articulation with the parietal remains.

(7) Right frontal fragment: Plate 1:- Row B, 3rd specimen. Number - A64/VII/(6). This small brownish fragment is from the supero-lateral corner of the orbit. The articulation for the zygomatic is present. Signs of rodent gnawing can be seen in 2 places.

(8) Right frontal fragment: Plate 1:- Row B, 4th specimen. Number - A64/VIII/(5). A brown coloured fragment of supero-lateral corner of orbit. The frontal surface is damaged, but the articulation for the zygomatic bone is present.

(9) Calvaria roof fragment: Plate 1:- Row B, 5th specimen. Number - A64/VIII/(5). A small fragment (parietal or frontal), showing extensive gnawing internally and externally.

(10) Right half of palate: Plate 1:- Row B, 6th specimen. Number - A64/VII/(4). The specimen consists of the alveolar and palatine processes of the maxilla, plus the small portion of the palatine bone enclosing the greater palatine foramen. The basal part of a large maxillary sinus can be seen from above. No teeth are present, but the alveoli, which are all present, suggest

that all of the teeth had fully erupted and were lost post-mortem. M^1 was three-rooted, M^3 single root and M^2 had a single fused root. The palate is deep and ridged, but generally rather small in its dimensions (maxillo-alveolar length - 57 mm. and breadth - 62 mm.; palatal depth - 13.5 mm.). The palate slopes down steeply anteriorly and there is no alveolar (or dental it would seem) prognathism. There is no palatine torus and the incisive foramen is small. The anterior surface of the maxilla is corrugated by the incisor root alveoli. The inferior margin of the anterior nasal aperture takes the form of a simian groove, the floor of the nasal cavity being very indistinctly demarcated from the anterior surface of the maxilla.

(11) Right ramus and posterior part of body of mandible: Plate 1:- Row C, 1st specimen. Number - A64/IV/(7). This yellowish fragment consists of the lower part of the ramus and a short posterior portion of the body of a mandible, all showing very extensive gnawing (Plate 6, row B). M_3 alveolus is present and the tooth appears to have been lost post-mortem. The alveolus shows that the tooth was double-rooted. The height of the body at M_3 is about 32 mm. and the ramus is antero-posteriorly broad, being about 39 mm. The mandibular foramen lies about 2 cms posterior to, and at about the level of, M_3 and there is no development of a lingula; the mylohyoid groove is short. Most of the gonial angle region has been lost, but, from what remains, the region appears to have been well developed. The submandibular groove is fairly deep; the alveolar prominence and the mylohyoid line are prominent. The trigonum postmolare is clearly delimited.

(12) Upper posterior part of left body of mandible: Plate 1:- Row C, 2nd specimen. Number - A64/N174.IV/(5). In this yellow-brown specimen the alveoli of the posterior molars (M_3 , M_2 and possibly M_1) are filled by the alveolar bone. The mandibular fossa is very deep and the mylohyoid line very prominent. The bone shows signs of crushing and gnawing.

(13) Mandibular symphyseal region: Plate 1:- Row C, 3rd specimen. Number - A64/IV/(5). This is a small fragment of the symphyseal region in which the upper and lower portions are missing. The only features of note are the well developed gonial tubercles on the inner surface.

(14) Left mandibular condyle: Plate 1:- Row C, 4th specimen. Number - A64/IV/(5). A small yellowish condyle, 20 mm. in breadth.

(15) Right mandibular condyle: Plate 1:- Row C, 5th specimen. Number-A64/VII/(4). A large yellowish specimen, badly damaged (breadth \pm 27 mm.).

(16) Right frontal bone: Plate 1:- Row C, 6th specimen. Number - A64/N174.IV/(5). A brown coloured fragment including most of the frontal part of the bone. The specimen shows little development of the superciliary ridges; the zygomatic trigone and glabella are mostly missing; but would appear to have been only weakly developed. There is no trace of an ophryonic groove. The fragment is difficult to orient correctly, but it would seem that the forehead region must have receded markedly. There are no traces of frontal bosses; the temporal lines show moderate development. Most of the coronal suture region is present and was fused endocranially. At bregma

the frontal bone projected posteriorly as seen in the Cohuna cranium.

(17) Left parietal bone: Plate 4:- Row D; Plate 5. Number - A64/N255.XV/(6). This large yellow fragment includes most of the central part of the left parietal, the portions adjacent to the coronal and lambdoid sutures having been lost; the posterior 1/3 of the region of articulation with the left temporal bone can be seen. A small central fragment of the right parietal is also present. The sagittal suture between the left and right parietal bones is synostosed endo- and ecto-cranially, and ectocranially there is heaping of bone in two places. Parietal foramina are present bilaterally for emissary veins; the temporal line on the left parietal is well developed. This specimen is noteworthy because of its considerable thickness (Plate 5): maximum 1.4 mm., average between temporal and mid lines about 1.0 mm. Endocranially numerous small foramina can be seen piercing the inner table of bone. They are situated in the vascular grooves on the endocranial surface.

(18) I_2 , left: Plates 2 and 3:- 1st specimen. Number - A64/IX/(5). This tooth is considerably damaged, the mesial 1/4 of the labial half of the crown and the whole labial half and distal 1/4 of the apical 2/3rds of the residual part of the root have been lost. The portions of the root which are present have a thin mineral encrustation and the apical 1/2 is blackened throughout its substance; the crown shows slight ante-mortem spotted staining. The tooth has the typical characters of a I_2 and arch form indicates that it comes from the left side. Wear on the incisal edge is quite considerable, but even

(one facet), and dentine is exposed. The dimensions of the tooth are: Mesio-distal length - 6.9 mm.; labio-lingual breadth - 7.0 mm. These dimensions match closely the only New Guinea specimen available for comparison, but they are larger than the mean values, although within the ranges, of the Aboriginal equivalents described by Campbell (1925). (The mesio-distal dimensions of this tooth and the 3 which follow are, of course, not the true maximum dimensions, because of the varying degrees of occlusal and interstitial wear to which they have all been subjected. Further, the small numbers and varying degrees of wear of the New Guinea teeth with which comparison is made render those comparisons of limited value only).

(19) P², right: Plate 2, 2nd specimen; Plate 3, 3rd specimen. Number - A64/IX/(5). This tooth is undamaged except for a small chip missing from the mesio-buccal part of the crown. The tooth shows very slight ante-mortem staining of the crown and there is slight mineral encrustation of the root, mainly on the mesial side. The overall contours of the crown and single root make the tooth clearly a P²; the slightly more mesial position of the lingual cusp and the distal inclination of the root place it on the right side. Wear on the occlusal surface is considerable and dentine is exposed; interstitial facets are present mesially and distally. There are slight signs of erosion in the region of the distal cemento-enamel junction. This tooth has a mesio-distal length of 6.0 mm. and a bucco-lingual breadth of 9.6 mm. The length dimension is short compared to those of 2 New Guinea equivalents to which it was compared and also to the mean figures and range for Aborigines given by

Campbell (1925); the breadth dimension is similar to that of the available New Guinea P^2 teeth and slightly narrower than the Aboriginal equivalents.

(20) P_2 , right: Plate 2, 3rd specimen; Plate 3, 2nd specimen. Number - A64/I/(7). This is an undamaged tooth showing slight mineral encrustation and colouring of the root and very slight staining of the crown. The cylindrical root and large crown, with markedly inrolled buccal surface, clearly indicate the tooth to be a P_2 . The tooth shows large mesial and distal interstitial facets and the occlusal surface is worn flat, exposing the dentine. The distal inclination of the considerably worn occlusal surface implies that the tooth comes from the right side of the mandible. The measured dimensions of the tooth are: mesio-distal length - 7.6 mm.; bucco-lingual breadth - 9.8 mm. The length is similar to that of the 3 available New Guinea specimens and also to the Aboriginal series described by Campbell (1925); the breadth is greater than that in the New Guinea specimens and just within the range of the Aboriginal equivalents.

(21) M^2 , left: Plates 2 and 3, 4th specimen. Number - A64/XII/(4). The buccal roots and apical tip of the lingual roots have been lost and there is slight damage to the distal part of the occlusal surface of the crown. The roots have a black encrustation and the crown has only very slight staining. The tooth shows a fair degree of wear, particularly on the lingual 1/3 of the crown, but dentine has not been exposed. There is a very large mesial and smaller distal interstitial wear facet. The tooth is 4-cusped and the mesio-buccal cusp is well developed, whilst the disto-lingual cusp shows slight reduction. The tooth is large, with a mesio-distal

length - 11.8 mm. and bucco-lingual breadth - 13.6 mm., which would tend to suggest its being an M^1 , but the lack of divergence of the lingual root and the relative sizes of the cusps seem to more strongly indicate that the tooth is almost certainly an M^2 of the left side. The tooth is slightly larger than the ranges for the dimensions of the equivalent tooth in 12 New Guinea specimens and slightly larger than the means but within the ranges of the Aboriginal equivalents in Campbell's series (1925).

(b) Axial skeleton (plus 2 uncertain fragments)

The 15 fragments recovered from Aibura which come from various parts of the axial skeleton are mostly too fragmentary to be of much value and will only be briefly listed. There is no clear indication of the number of individuals represented, but it could even be only one. These fragments (plus the 2 doubtful specimens also described below) are all illustrated in Plate 4 and reference is made to the various specimens by a capital letter (A, B or C) referring to a row, and a number (1-8), giving its position in the photograph from the side of the row nearest the letter.

(1-6) Small fragments of thoracic vertebrae: A1-5, 7. Numbers - A64/X/(4). A3 shows signs of charring.

(7) Lower thoracic vertebral body fragment: B1. Number - A64/VII/(5).

(8) Thoracic vertebral body fragment: B5. Number - A64/XI/(4).

(9) A fairly complete lumbar vertebral body (L5): C1. Number - A64/85.X/(4).

(10) Lumbar vertebral body fragment: B4. Number - A64/XI/(4). Slight blackening possibly due to charring.

(11) Small fragment of a lumbar vertebral body: A6. Number - A64/X/(4).

(12) Fragment of ala of sacrum: A8. Number - A64/X/(4).

(13) Sacral fragment from right superolateral side: B6. Number - A64/XI/(4).

(14) Sacral fragment, probably superolateral part: C3. Number - A64/IX/(6) shows signs of gnawing.

(15) Left superolateral part of manubrium sterni: C2. Number - A64/VII/(6).

(16 and 17) 2 specimens too small for identification: (1 at least - B3 - possibly from a vertebral body): B2 and 3. Number - A64/VII/(5).

Most of these specimens have a basically brown colour, but three are slightly lighter (B6, C2 and C3), while C1 is much lighter; four specimens are darker (A4, A5, A8 and B4).

(c) Upper Limb

The upper limb fragments from Aibura are all illustrated in Plate 7, except for the last specimen which is not illustrated. They are few in number and either small fragments or bones which are not especially informative.

(1) Right clavicle, lateral half: A1. Number - A64/XV/(4). This is a yellowish coloured specimen and the portion preserved is in reasonably good condition. The lateral supero-inferiorly flattened part of the specimen is slightly damaged, but was clearly relatively small; the

oval-shaped more medial part is slightly more substantial. Overall, the specimen would seem to have come from a small, lightly built individual, possibly young, female or both.

(2) Head of left humerus: A2. Number - A64/35.XI/(3). This specimen comprises the major portion of the articular surface of the head of a left humerus. Two small parts of the adjacent shaft of the bone have been forced into the cancellous under-surface of the fragment. The articular surface of the specimen is coated with a thin, mostly black, mineral encrustation.

(3) Small fragment, probably of head of humerus: A3. Number - A64/IV/(5).

(4) Small fragment of long bone shaft, possibly radius: A4. Number - A64/35.XI/(3).

(5) Right scaphoid: B1. Number - A64/IV/(5). Yellowish, well preserved.

(6) Right 4th metacarpal: B2. Number - A64/IV/(5). Brownish-yellow, proximal end slightly weathered.

(7) Distal half of right 1st metacarpal: B3. Number - A64/IV/(5). Blackish, damaged fragment.

(8) Proximal phalanx, 1st digit, right hand: C1. Number - A64/X/(4). Blackish mineral encrustation.

(9) Proximal phalanx, probably 3rd digit: C2. Number - A64/X/(4). Brownish, with blackish mineral encrustation.

(10) Proximal phalanx, 4th or 5th digit: C3. Number - A64/VIII/(5). Dark brown in colour.

(11) Proximal phalanx (proximal end lost): C4.
Number - A64/XIV/(4). Yellow in colour.

(12) Intermediate phalanx, epiphysis lost and distal end damaged: C5. Number - A64/XI/(4). (Epiphysis fuses to shaft at about 17-19 years of age).

(13) Proximal half of intermediate phalanx. Number - A64/XIII/(1). Brownish.

(d) Lower Limb

The lower limb material recovered is all illustrated in Plate 8, except for the last three specimens which are not illustrated. More than one individual is represented and, although two long bones are present in most of their extent, one end is missing in each case and accurate stature determination is not possible.

(1-4) Right tibia minus head: A1, 2, 3, 4. Numbers - all A64/85.XI/(4). The four fragments comprising this specimen are well preserved, brownish coloured and a few areas are covered with a blackish mineral encrustation. The bone shows no unusual features and clearly came from an adult individual of substantial size. (Maximum length, ± 35.5 mm.; mid-shaft antero-posterior diameter, ± 31.5 mm.; mid-shaft medio-lateral diameter, ± 20.5 mm.; stature, based on adult white estimates, would be about 1625-1650 cms - Comas (1960). There are no squatting facets on the anterior lip of the inferior articular surface, but the inferior end of the medial malleolus is rather blunt.

(5) Left tibia, proximal 2/3: B1. Number - A64/38.XI/(3). A well preserved yellow specimen with a fairly thick, black mineral encrustation, particularly

distally. This specimen probably comes from the same individual as fragments (1) to (4). The specimen agrees with the previous 4 in many small anatomical details and likewise suggests a substantial adult individual. Platycnemic index - 63.9, which is mesocnemic. There is a 4 cm. long gnawed area on the postero-lateral part of the shaft.

(6) Left tibia, distal 1/3 but lacking distal end: Fragment on right between rows B and C. Number - A64/37.XI/(3). A small fragment with a thick, black, mineral encrustation, probably of the distal part of the bone just described (5).

(7) Left femur, proximal 1/3, but no head: B2. Number - A64/229.I/(8). A robust yellow fragment, in which the whole posterior surface shows extensive signs of gnawing (Plate 6,A) and of which the distal end is blackened, possibly as a result of charring.

(8) Right talus: C1. Number - A64/IV/(7). A brownish coloured specimen of which the posterior part has been lost.

(9) Right talus: C2. Number - A64/85.X/(4). A complete specimen with blackish encrustation. Slightly larger than specimen (8) and showing no unusual features.

(10) Right cuboid: C3. Number - A64/IX/(4). Yellowish with some blackish encrustation.

(11) Left medial cuneiform: C4. Number - A64/XIII/(4). Lateral half of the bone is missing, but the bone was clearly small. Lower surface yellow, upper surface blackened, possibly due to charring.

(12) Left lateral cuneiform: C5. Number - A64/IV/(5).
Badly damaged fragment.

(13) Tarsal bone, possibly cuboid fragment: C6.
Number - A64/IV/(7). Yellow.

(14) Tarsal fragment, probably calcaneum: C7.
Number - A64/VII/(5). Brown.

(15) Right 2nd metatarsal: D1. Number - A64/X/(4).
Specimen completely covered by greyish encrustation.

(16) Left 5th metatarsal: D2. Number - A64/IV/(7).
Well preserved brownish specimen.

(17) Proximal phalanx of right foot: D4. Number -
A64/X/(4). Small fragment of bone only; blackened,
probably by fire.

(18) Proximal phalanx, left foot (2nd, possibly 3rd
digit): D5. Number - A64/VII/(7). Well preserved, brown
coloured bone.

(19) Proximal phalanx, 1st digit (hallux), left foot:
not illustrated. Number - A64/XI/(4). Yellow with black
encrustation. Large specimen.

(20) Proximal part of 2nd metatarsal, left foot: not
illustrated. Number - A64/IV/(5). Yellowish fragment,
considerably damaged.

(21) Left tibia, midshaft (1/6): not illustrated.
Number - A64/IV/(5). Pale yellowish fragment with
evidence of rodent gnawing.

Archaeological associations (J.P.W.)

During excavation, the following associations suggested themselves: 255 and XV/(4); 35, 37 and 38; I/(7) and IV/(7) and questionably 229 and 174; 85 and questionably 229 and 174. Unfortunately a large proportion of the material (54/82 specimens) was not detected in the field and it is only located to a specific square metre and to a specific level within this.

Later assessment, made in the light of the stratigraphy, overall distribution of remains and Dr Freedman's identifications suggest that remains of at least three individuals are present. There seem to be three clusters of fragments in the site, namely:

- i) X/(4), XI/(3)-(4), XII/(4), XIII/(4), XIV/(4), XV/(4)
- ii) IV/(5), VII/(4)-(6), ?VIII/(5).
- iii) I/(7)-(8), IV/(7).

In addition there are a few fragments which are not definitely associated with any one cluster. These associations seem to be in line with the identifications, which suggest a few individuals. So much of the bone is fragmentary that most human remains were probably deposited in a fragmentary or at least dis-articulated state, i.e. as a secondary burial.

Summary

The 86 human bone fragments recovered from the Aibura Cave are mostly small and few are well preserved. Some show signs of weathering and others have a blackish mineral

encrustation. There are signs of probable rodent gnawing on about 9 fragments (mostly of the skull) and about 11 fragments (8 from the skull) show blackening, which appears to be charring due to fire. No obvious signs of pathology were found in any of the specimens, but the very thick parietal bone (N225.XV/(6)) did suggest the possibility of Paget's Disease, until study of its measurements (and structure) indicated that the thickness was within the range of variation showed by the comparative New Guinea and Australian material.

It is difficult to assess how many individuals are represented by the material. From the upper limb, teeth and axial skeleton remains, it could be a single individual, but from the lower limb and skull fragments it is clear that the bones of at least 2 individuals are present. Overall consideration of the material indicates a minimum of two individuals, but the individual age differences indicated by epiphyses at the one extreme and fusing of the parietal bones at the other, suggest that 1 or more additional individuals could be present. Archaeological association does not assist greatly in assessing the number of individuals represented.

With regard to the sex of the individuals represented, the temporal fragment with the small mastoid process (A64/IV/(5), the small palate (A64/VII/(4), small mandibular condyle (A64/IV/(5), each point to a female (or young) individual, whilst the large tibiae (A64/85.X/(4), A64/38.XI/(3) and A64/37.XI/(3)), thick parietal (225.XV/(6)) and large mandibular ramus (A64/IV/(7)) and condyle (A64/VII/(4)) each suggest a male, probably large.

The most significant fragments with regard to race determination are the heavy thick parietal bone (225.XV/(6)) and the receding forehead of specimen A64/174.IV/(5). Insufficient comparative material is available from New Guinea to make any accurate assessment, but New Guinea skulls with similar morphology are present in the collection of the Department of Anatomy, University of Sydney. Further, it is of interest to note that these 2 Aibura specimens can be matched almost exactly in the Aboriginal Australian material in that same collection.

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Acknowledgements

It is my pleasure to thank Mr A.B. Bailey, Department of Anatomy, University of Sydney, for assistance with comparative material and identifications of the above specimens.

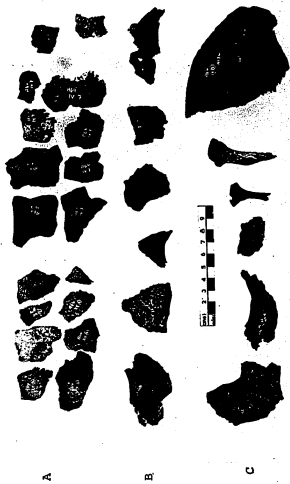


Plate 1. Human skull fragments. See text for description and numbers.



Plate 2. Labial/buccal view of human teeth.

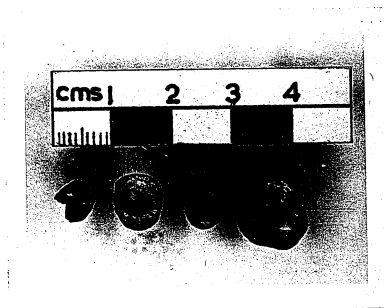


Plate 3. Occlusal view of human teeth.

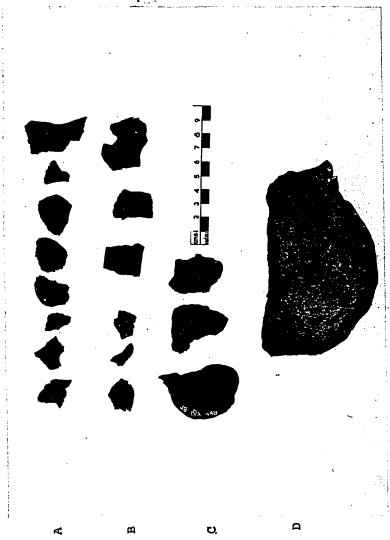


Plate 4. Human axial skeleton fragments and one calvaria fragment (D).

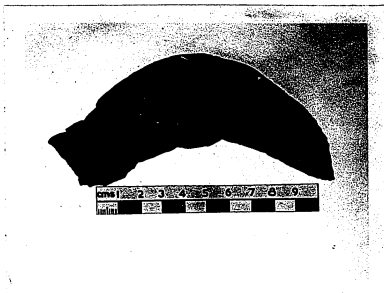


Plate 5. View of human calvaria fragment (A64/N255.XV/(6)) to show thickness of bone.

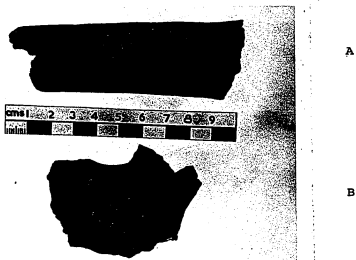


Plate 6. Two examples of gnawing on human skeletal fragments. A - femur (229.1/(8)); B - mandible (IV/(7)).



Plate 7. Human upper limb skeletal fragments.

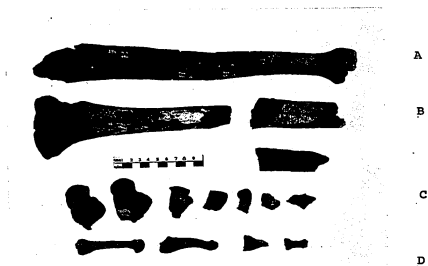


Plate 8. Human lower limb skeletal fragments..

APPENDIX 6.2

THE PETROLOGY OF THE POTTERY FINDS AT AIBURA

C.A. Key, Department of Anthropology
and Sociology (Archaeology),
Australian National University.

Thin sections of six sherds were examined under the petrological microscope. Two other thin sections from pots of known origin were made for comparison.

All the sherds examined were coarse, more or less oxidized earthenware of varying thicknesses.

Sherds nos VI/(3), VIII/(3), 22.IX/(3), XV/(3) and the sherd of an Agarabi type pot,¹ all resemble one another in that their clay bodies contain granitic rock-fragments, K-Na feldspar, quartz and some green hornblende.

Sherd no. XIV/(3).1 is a thin (4 mm.), well fired sherd which contains very different types of filler. The filler is fine-grained, <.2 mm., and consists of angular pyroxene and feldspar as well as shell fragments, one of which may be a foram.

Sherd no. 239.XIII/(3) is part of a decorated rim. It is made up of two distinctly different materials. The clay used for making the pot contained, as impurities,

¹ This was collected by P.J.F. Coutts in 1966 from the Agarabi area. See Watson, 1955, for a general description of this pottery.

rounded and very weathered fragments of basalt and pellets of limonite (lateritic). This clay was mixed with a filler which consisted of fresh, large (>.5 mm.) angular fragments and euhedral pyroxene and some fresh feldspar.

A sherd from a Markham type pot¹ was also examined. The clay body contains a large amount of very weathered material, both rock fragments of gabbro and tuffs and fairly large books of oriented clay which may represent the remnants of weathered ferromagnesian minerals. These inclusions in the clay seem to be a natural part of the clay and not an added filler.

There are therefore three types of pottery in the excavated material, none of which are similar to the present day Markham pottery.

Four of the sherds have inclusions which resemble the present day Agarabi type raw material originating in the palaeozoic metamorphosed sediments of the Eastern end of the Bismarck Range. The excavated sherds are however thin (down to 3 mm.), and well fired while the Agarabi pots are very thick and badly fired (Watson, 1955, p.123).

The two other sherds contain the pyroxene-feldspar association often found in pottery from volcanic terrain. One however is made on the coast as evidenced by the shell inclusions, while the other has a more coarse-grained filler and must be from a different locality.

¹

This was collected by J.P. White at Barabuna village, base camp for the Aibura excavation, 1964. See Hölzknacht, 1957, for a general description of some Markham pottery.

The Markham pottery contains its own peculiar inclusions and it would seem to have been made from impure river clay.

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APPENDIX 7.1

THE FORMATION OF THE DEPOSITS AT
KAFIAVANA : THE RESULTS OF A SEDIMENTARY ANALYSIS

Elisabeth Schmid and Irmgard Grüninger,
Laboratorium für Urgeschichte,
Universität Basel. Translated by
Christian Kaufmann, Museum für
Volkerkunde, Basel.

together with

Some Comments on Prof. Schmid's analysis. J.N.
Jennings and R.M. Frank, Department of Geography, Research
School of Pacific Studies, Australian National University.

The soil samples were examined according to the various methods described by E. Schmid (1958, 1963). First the samples were washed (elutriated) to show the grain size of material finer than 2 mm. in diameter (<2 mm. ϕ). This material was divided into six size fractions (see table). The coarser elements (>2 mm. ϕ) were analysed by sieving into five size fractions (see table). The elutriated and sieved material was inspected microscopically to look for the different elements which composed the soil. Chemical tests were used to define the proportions of Ca CO₃ (lime), phosphate and humus (Schmid, 1958, pp.34-6). The results obtained are given in the table at the end of this report. Columns 4 and 5 show the

percentage occurrence of the different grain-size groups in the elutriating (<2 mm. ϕ) and sieving tests (>2 mm. ϕ). Column 6 gives the percentage of calcium carbonate. Columns 7 and 8 indicate the phosphate and humus contents by reference to colour-values (Schmid, 1958, pp.35-6). Column 3 sets out the Munsell soil colours of dry samples inspected in the laboratory.

All these results have been compared and discussed in the light of experience gained in interpreting similar material from Western and Central Europe and Northern America including Alaska. In the evaluation of these soils special emphasis was laid on the granulometric analysis of the soil material.

General Principles

1. As a general rule it may be said that a high percentage of clay (fraction I, <0.02 mm. ϕ) may result from a) intense chemical destruction of rock or loose sediments or
b) sedimentation in still water.

The presence or absence of CaCO_3 and the nature and type of coarse elements will allow a choice between a) and b) to be made.

2. Aeolian sedimentation has occurred where there is a very high percentage of fraction II (0.02-0.05 mm. ϕ) and where fraction I is between 50 per cent and 100 per cent of fraction II. The relative quantities of coarser fractions allow a distinction to be made between material of a loessic character and drift sand.

3. If there are similar percentages of fractions I (<0.02), II ($0.02-0.05$), III ($0.05-0.1$ mm. ϕ) and IV+V+VI ($0.1-2.0$ mm. ϕ), sedimentation of very fine grains in a quiet bay of a river valley or by flooding is indicated. In German this is called 'Auelehm', i.e. 'ewe-clay'.

4. The carbonate content of a soil may be the same now as at the time of soil deposition, or it may have been lessened by secondary dissolution or increased by infiltration. Traces of the different processes are visible microscopically.

5. The phosphate content of a soil is generally increased by human or animal activity, due to the decomposition of faeces and wasted meat in the soil. The humus content, however, may be due to the autochthonous formation of soil or to man or animals bringing plants into the shelter and allowing the rotting remains to accumulate there.

In a humid climate both phosphate and humates may be increased due to infiltration of the lower strata from those above, though the amount of material infiltrated depends on the force of the washing-in process. The humus content may at times be reduced by the burning out of organic material by strong fires made in a pit.

These general principles have been used in determining the origins of the sediments and the processes of sedimentation at Kafivana.

The results of the analysis

There are 21 soil samples. No. 21 is a sample of sterile clay at the base of the section while nos. 1-20

are taken from alternate 10 cm. of a soil column, numbering from the bottom up.

(i) Basal clay, found also between the cultural layers and the rock wall at the rear of the site. The elutriation analysis shows that there are almost equal percentages of fractions I, II and III (<0.02 , $0.02-0.05$, $0.05-0.1$ mm. ϕ); this percentage distribution is similar to that found in the 'Auelehm' (ewe-clay) in Western Europe. In addition, the unusual presence of manganese and probably limonite concretions in most fractions also suggests that this soil was sedimented in water, combined with occasional drying.

Some grains, including some smaller pebbles, are covered in places with manganese but are normally clean. This, the presence of many quartz crystals in the fine-grained fractions, the fact that many small pieces of limestone are slightly corroded and the low content of CaCO_3 (9 per cent) confirm that this sediment was deposited in a special way. This sediment was then probably formed by non-autochthonous material, which might even be of volcanic origin, carried in by water with a low lime content. The deposit being close to the rock wall some other materials - pieces of limestone, pieces of naturally broken siliceous minerals, small fragments of animal bones, egg and snail shells - were also easily incorporated. It seems very likely that this sediment was formed by repeated floodings and we think it probable that it is a remainder of pluvial times.

(ii) Zone A, 75 cm. thick, samples 1-4, is the lowest of the five different soil zones we have distinguished in the cultural layers.

Sample 1 shows no trace of immediate human presence. Its small clay grains are strongly stuck together by lime sinter and the humus content is high. The impression is that decayed parts of the rock wall were deposited under wet conditions together with lots of rotted plants.

In samples 2-4 fraction VI (0.5-2 mm. ϕ) increases steadily. The high percentage of burnt clay lumps shows that the site was used as a living place. In samples 3-4 the humus content decreases.

(iii) Zone B, 1.4 m. thick, samples 5-11, is remarkable for the high proportion of fraction II (0.02-0.05 mm. ϕ) throughout. In this, the sediment is very similar to loess. However, microscopic examination does not reveal the large amounts of quartz which characterises loess. Rather, it is very similar to the clayish sediment which is called 'parna' in Australia. Woldstedt (1965, p.122 after Butler and Hutton 1956) says of this, 'These parna-formations must have been mainly blown out of existing soils during periods of dryness'. We are sure that this sediment is not a volcanic aeolian sediment since these do not contain lime at all whereas CaCO_3 values for the aeolian sediment at Kafiavana are 40-66 per cent.¹ The low humus content makes it probable that sedimentation was rather rapid and there were only a few plants rotting on the site.

(iv) Zone C, 60 cm. thick, samples 12-14. In the material of <2 mm. ϕ the coarser fractions are mainly made

¹
Compare for example the analysis of pumice sediments of Jaguar Cave, Idaho. See E. Schmid in H. Kooros-Sadek, 1966.

up of burnt clay. A high intensity of human occupation in sample 14 is indicated by the coarser fraction in the sieving test and an extraordinarily high phosphate content. The high quantity of humus in sample 14 may be due to infiltration from sample 15, but at least part could have been brought in by man, e.g. for a fireplace. It is remarkable that the small pebble grains present in the upper part of zone B and in zones D and E were absent here.

(v) Zone D, 60 cm. thick, samples 15-17, is similar to Zone B in its high percentage of fraction II (0.02-0.05 mm. ϕ), although sample 15 is transitional. Apparently a sort of 'parna'-formation was again in progress though for a shorter time and with the deposit being more intensely affected by human activity. The high humus content of levels 14-16 may indicate that the surface during sedimentation was seasonally open to the growth of plants for a longer time, and the rotting of these plants produced humus. The high quantity of phosphate in samples 14-16 does not contradict this as the phosphate is of primary origin - i.e. is the product of human occupation during the formation of these sediments.

The section photographs show several big (up to 20 cm.) angular stones at this level. Like the small pieces of limestone in the samples they originated most probably from the rock wall. If they were not deposited by man,¹ they confirm the climatic peculiarities of this time.

(vi) Zone E, 35 cm. thick, samples 18-20 is not a unit on the basis of either the mechanical or chemical

¹ They probably were not. [J.P.W.]

analyses. It seems likely that sedimentation has been effected by human influences and the decomposition of the parent rock.

Observations on different ingredients in the samples

The microscopic inspection of residues from the elutriation and sieving tests showed the sediments had the following peculiarities:

Roots of recent age are present down to sample 3; they are enclosed by rootlet tubes which occur alone in samples 1 and 2.

There is a high proportion of elements with a diameter of >10 mm. ϕ or even >20 mm. ϕ in zone A. They consist of clayish lumps of sinter and superficially corroded pieces of limestone,¹ some of which are covered on the lower side with a grey lime sinter.

Biggish flakes of siliceous minerals (>10 mm. ϕ) are numerous in the two lowest samples of zone B. Very small flakes which can be identified even in fraction IV (0.1-0.2 mm. ϕ) are present in all samples from 3 onwards. These very fine flakes indicate that retouching work was done on the site. Quartzite, rock crystals and agates are the most prominent varieties of siliceous minerals present.

The small clay lumps present in all zones from sample 2 upward mostly have a rough surface. Their cohesiveness comes partly from burning and partly from the lime sinter. The clay was apparently frequently intermingled with short

¹ Actually calcareous siltstone. [J.P.W.]

chopped plants, the impressions of which were preserved in the lumps.

Fragments of bones and teeth are found in all layers and partly burnt fragments in all samples except 1 and 19. The species of animals cannot be determined but the teeth in the basal clay resemble those of rodents.¹

Other remains of animals include small pieces of egg shells and fragments of snail shells. The egg shells may have fallen naturally from nests above. They are present as single and small plates in all samples (including the basal clay) except 1, 17, 18 and 20. Thin fragments of small snail shells clearly record an autochthonous fauna. They occur in the basal clay, zone A, samples 5, 6 and 10 of zone B, samples 15 and 17 of D and 18 and 20 of zone E. This suggests that an analysis of snails could reveal the local climate and its fluctuations. For example a snail from level 1 resembles the Western European Goniodiscus which is a forest dweller.

Sixteen small fish vertebra were found in samples 4, 13, 15 and 16; the specimens in 15 and 16 were partly burnt.

Charcoal occurs only in very small pieces and is not found in all samples. It is present only in sample 1 (zone A) and is completely missing in zone B. Above this it occurs only in 12, 14, 16, 17, 19 and 20.

¹

See Appendix 3.2 [J.P.W.].

Summary

The samples were too small to give a numerical expression of the intensity of human occupation. The presence of man above level 1 is however confirmed throughout by the small flakes of siliceous materials and the small burnt lumps of clay which were partly interspersed with plant impressions.

The basal clay was probably settled as *ewe-clay* during the last pluvial period. Some volcanic material may have been included in it.

During the formation of zone A human influence became more important. These layers were deposited under a humid climate and include disintegrated parts of the rock wall. Perhaps this documents the last oscillation at the end of the pluvial period.

The sediments of zone B can be defined as a sort of 'parna', i.e. an aeolian sedimentation of soil particles. There must have been a dry period, we think during the period of deglaciation at the end of the Pleistocene. Only in a dry climate could enough ice be melted in the New Guinea Highlands to make the glaciers retreat. Further, we know that in the northern hemisphere the Pluvial period ended at about 10,000 B.P. (Behre, 1966, p.76). As a hypothesis, we suggest that this immediately post-glacial time, after 10,000 B.P., would have been the best period for the deposition of the aeolian sediments in zone B. The sedimentary analysis therefore confirms the range of the typological and radiocarbon dating and suggests the environment which prevailed at that time. It should be possible to find further proofs of the dryness

of zone B period in the pollen and animal remains. The snails could be used as an indicator of local climate.

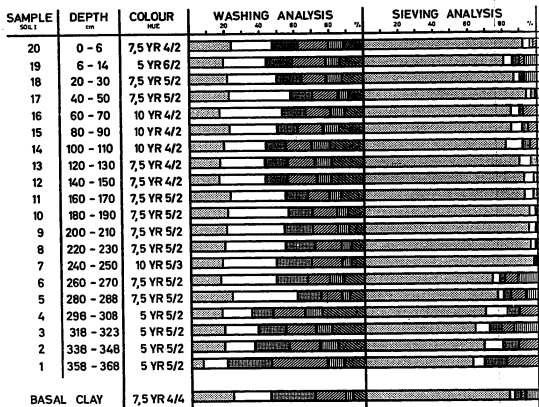
The wet phase of zone C can be compared with the 'Atlanticum' of the northern hemisphere. It is followed by a short and temporarily dry period with the formation of 'parna' - our zone D. It is not yet possible to give an absolute date for this. Our knowledge of the post-pluvial climatic changes in New Guinea is too limited yet to comment on the C¹⁴ date of ca. 4500 B.P. However, it must be remembered that the site may have been abandoned for a while at the end of this dry period. We consider that zone E was formed during a more humid climatic phase.

The following table summarises the relevant results of our analysis (see next page).

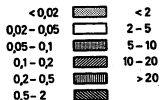
Literature cited

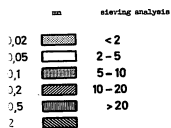
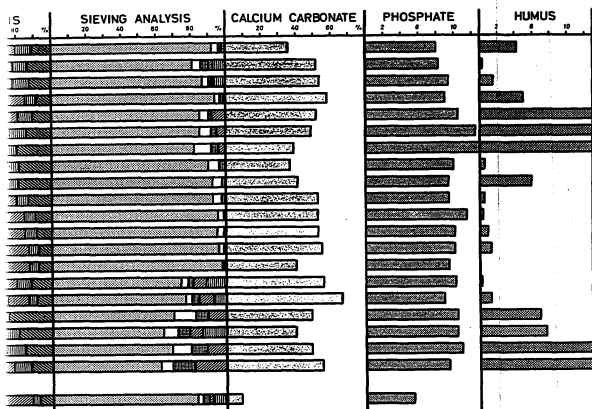
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Depth (metre)	Zone		Sediment	Climate	Time B.P.	
					Geological	C ¹⁴
0.35	E	sediment with cultural remains		humid		
	D		parna-like aeolian	temporarily dry		c4500
0.95						
1.55	C			humid	7500	
2.95	B		parna-like aeolian	dry	10,000	9000- >9500
	A			humid		
3.70	Basal clay	semi- fluviatile: 'Auelehm'	pluvial			



washing analysis mm sieving analysis





Some comments on Prof. Schmid's analysis.
J.N. Jennings and R.M. Frank, Department of Geography,
Research School of Pacific Studies, Australian National
University.

We consider that while the report gives a sound and useful picture of the soils in the shelter we do not think that it provides adequate evidence for the inferences which are made about either the climate or the local environmental conditions under which deposition occurred. We do not believe that principles derived from the study of soils in temperate Europe and America should be used, without consideration of local conditions, in tropical New Guinea. We agree with Professor Schmid that climatic inferences may be better drawn when more evidence from several disciplines is available, but consider the present attempt is premature. We consider that Professor Schmid's interpretation is simply one among a number of possible explanations of the data.

We point out specifically:

(i) While the precipitation of manganese and limonite concretions does imply oscillations in the quantity of locally available water, they are not necessarily deposited in water. Even if water were present, this need only reflect very local conditions.

(ii) Although Professor Schmid refers only to 'parna-like' soils, it would perhaps be better simply to use the term 'aeolian'.

'Parna' in Australia is not a uniform sediment.
Several rather different materials have been called parna:

it is defined not only by its particle size but also by such features as its stratigraphic relations with sand dunes, fluvial deposits etc. Several parnas are superimposed in some areas and were formed in different periods.

A careful and accurate description of the 'parna' referred to by Schmid is clearly necessary. For example, in Wiggelli parna the clay fraction (<0.002 mm.) ranges from 29 per cent to 69 per cent (mean 59 per cent) of the material <2 mm. in size.¹ This is considerably more clay than in any Kafiavana sediment. One might also wonder where, in the Highlands, possible sources of parna occur.

(iii) Professor Schmid refers to the large angular rocks in zone D as supporting her interpretation of dry conditions. Moist conditions, leading to erosion and disintegration of the rock wall would be equally likely to bring down geometrically shaped rocks. Further, since Professor Schmid has not handled these boulders her judgement as to the angularity and sharpness of their edges must be tentative.

(iv) It is not clear that glaciers in the Highlands would only melt in a dry climate. Studies in some other parts of the world show that ablation by warm rain is at times a more important cause of glacial retreat than melting by the sun. We know too little about local conditions in the Highlands to make a generalisation about this.

¹ E.E. Butler and J.F. Hutton, 1956, pp.544-5, 548.

(v) From the table it appears that a high percentage of fine silty sediment (<0.05 mm.) tends to be correlated with a high percentage of CaCO_3 (see especially samples 5, 17). If the finer sediment is in fact aeolian it is difficult to explain the presence of more CaCO_3 . The correlation of these two things tends to suggest local seepage within the shelter has brought down both fine sediment and lime: the variation would therefore be due to local and not large scale effects.

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APPENDIX 7.2

FAUNA FROM THE BASAL CLAY AT KAFLAVANA

M.D. Plane, Vertebrate Palaeontologist,
Bureau of Mineral Resources, Geology
and Geophysics, Canberra.

The only families represented in this sample are Macropodidae, Phalangeridae and Muridae. Both modern and extinct forms occur.

Murid material is most abundant, being represented by more than twenty incisors, a cheek tooth and post-cranial elements. Both large ('giant') and small rodents are found in the fauna. The cheek tooth can be assigned to Rattus. Little is known of the antiquity of the murids in New Guinea. A small murid is known from the Pliocene and Simpson (1961) has speculated that the murids must have been in or passed through the island since the Miocene.

A phalangerid mandible assignable to Petaurus is the sole representative of this family. Petaurus is the sugar glider extant today along the Australian eastern seaboard, Cape York, Arnhem Land and in the forests of New Guinea.

The Macropodidae are represented by a single broken upper molar, probably M^2 or M^3 . No definite assignment can be made for this tooth which has similarities to the genera Protemnodon and Sthenurus. The stage of evolution of this macropod is difficult to assess on this

fragmentary tooth. It is low crowned, has a narrow steep median valley, weakly developed mid-link and the labial end of the median valley is blocked by anterior and posterior spurs from the metacone and paracone, the posterior cingulum is small and confined to the back of the tooth.

Both Protemnodon and Sthenurus are extinct today. Protemnodon is the predominant macropod in the Pliocene of New Guinea (Plane, 1967), while Sthenurus has not been reported from the island. In Australia Protemnodon is the predominant macropod in Pleistocene deposits (Stirton, 1963) and is abundant in the Pliocene; it has a questionable record back in the late Miocene (Woodburne, 1967). Sthenurus occurs only south of a line from Chincilla (Queensland) to Lake Eyre: it occurs in deposits of possible Pliocene age and is abundant in the Pleistocene (Tedford, 1966). Both Sthenurus and Protemnodon are grazing rather than browsing animals and the presence of either can be taken to indicate the existence of open grassland.

It is difficult to imagine how the macropod tooth may have been introduced into the deposit. A carnivore's den seems to be unlikely since we know of no carnivore large enough to have preyed on a macropod which was probably as large as the living red kangaroo. Human activity is ruled out since the basal clay predates human occupation.

It should be noted that this specimen may possibly be derived from older material since the type of permineralisation seems to differ from that of the other specimens. Were it not for this, a Pleistocene age would be appropriate for the fauna and still seems most likely.

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APPENDIX 7.3

POLLEN ANALYSIS OF SOME SAMPLES FROM KAFIAVANA

J. Wheeler and W. Litchfield, Department
of Geography, Research School of Pacific
Studies, Australian National University.

1. Analysis of coarser material.

All samples are made up of clay and rock fragments of various sizes. Charcoal is present in all, abundant in 20. Plant fibres and rootlets are common in 9 and 17, few in 18, and absent in 20.

2. Pollen extraction.

Two main methods, and some modifications of these, were used for extraction:¹

a) HF method - material treated with KOH (Potassium hydroxide), HF (hydrofluoric acid) followed by acetolysis.

b) Gravity separation method - material dispersed in sodium polyphosphate, frothed with polyvinyl alcohol followed by ultrasonic agitation and ZnBr (zinc bromide) flotation; followed by acetolysis.

The latter method was the only one which gave results. In this case a 10 gm. sample of 20 gave a recovery of

¹ K. Faegri and J. Iversen, Textbook of Pollen Analysis, Munksgaard, 1964.

100+ grains, showing that while pollen was present it was in very low concentrations. About 7 pollen types were present, together with a few spores. Some Myrtaceae and Gramineae were identified along with one grain each of Casuarina and Wahlenbergia. No Ipomoea batatas was seen.

For better results modification of the gravity separation method is required plus some method of reducing the carbon content.

One possible explanation for the low concentration of pollen is the amount of burning which has obviously taken place. An oxidising atmosphere must be present at these times and destroy most of the pollen.

APPENDIX 7.4

KAFIAYANA - WASTE STONE

Sample no.	Horizon	Spits	Sizes (inches square)						Total no.
			>2	2-1 $\frac{1}{2}$	1 $\frac{1}{2}$ -1	1- $\frac{1}{2}$	< $\frac{1}{2}$		
1	I	G4/3	1	1	9	138	364	513	
		G3/2	2	16	77	540	698	1333	
2	I-II	H4/2,3,4	2	1	12	158	460	633	
		H3/3	-	7	35	271	409	722	
3	III-IV	H3/4	2	6	24	186	334	566	
		H3/4(Pit)	-	7	40	202	315	566	
		H4/12	-	1	25	153	273	452	
		H4/13	-	5	44	210	615	874	
		H3/14	-	7	42	226	322	597	
		H3/15	1	6	30	341	682	1060	
4	IV	G5/10	1	7	42	263	288	601	
		G5/11	2	12	56	309	518	897	
5	VIII	G5/13	2	4	34	209	348	597	
		G4/42	4	11	57	265	560	897	
		G4/43	2	12	50	219	384	667	
		G4/44	2	4	48	200	266	520	
6	VIII-IX	F4/14	-	7	36	211	273	527	
		F4/15	2	3	27	133	174	339	
		F5/20	4	9	18	92	208	331	

χ^2 values, within samples (calculated by Dr W. Ewens).

Sample 1	57.57	very significant
2	59.59	very significant
3	56.26	very significant
4	19.22	not significant at 0.1 per cent level
5	20.70	not significant at 0.1 per cent level
6	11.42	not significant at 1 per cent level.

For the purposes of analysis two groups were made

I = samples 1, 3, 6.

II = samples 2, 4, 5.

χ^2 values between the samples within each group were calculated.

χ^2 for I = 48.74 extremely significant.

II = 35.72 extremely significant.

APPENDIX 7.5

HAMMERS AND ANVILS FROM KAFIYANA

Hammers

Horizon	Reference	Whole/Broken	Wgt (gm.)	Material ¹
I	G3/5	W	598	Hornblende-porphry
I	G2/14	W	83	Basaltic
I	H4/5	W	590	Basalt
III	G4/42	B	70	Feldspar-porphry
III	F3/(13)	B	195	Hornblende-porphry
III	H2/75	B	200	"
III	H2/111	B	113	"
III	H4/18	B	140	Tuff
IV	G3/(15)	B	375	Diorite
IV	G5/41	B	315	Basalt
IV	H2/147	B	246	Hornblende-porphry
V	G4/89	W	295	Feldspar-porphry
V	G4/94	W	275	Basalt
V	F3/126	B	219	Basalt
V	F6/22	W	320	Porphyry (ochre traces)
VI	F3/(33)	W	376	?Hornblende-diorite
VI	F6/73	W	910	Hornblende-porphry
VII	G3/154	W	870	Tuff
VII	F5/19	W	425	Feldspar-porphry
VII	H3/146	B	160	Feldspar-porphry
VIII	G4/149	W	210	Basalt
VIII	G4/150	B	280	Tuff
VIII				Feldspar-porphry

¹ All identifications by Mr. C.A. Key, Department of Anthropology, A.N.U.

Horizon	Reference	Whole/Broken	Wgt (gm.)	Material
VIII	G4/(41)	B	105	?Hornblende-diorite
VIII	G5/96	B	315	Porphyry/feldspar-porphyry
VIII	F4/20	B	455	?Hornblende-diorite
VIII	F5/(20)	W	1270	Tuff

Anvils

Horizon	Reference	Whole/Broken	Wgt (gm.)	Material
VI	F3/135	B	731	Hornblende-porphyry
VI	F3/152	W	89	Porphyry
VII	G4/143	B	890	Hornblende-porphyry
VIII	F4/23	W	1315	Tuff

APPENDIX 9.1

DESCRIPTIVE LISTS OF PAINTINGS FROM EXCAVATED SITES1. Batari¹

This list records the paintings along the east face working from south to north (1-16) and then on the north face moving west (17-31). All descriptions are given as if facing the design. Where not specified, the vertical measurement is given first.

1. An unpainted Greek cross with each quadrant containing a series of six concentric red-line irregular squares. The design is narrower at the top (12 cm. wide) than at the base (20 cm. wide). The whole design is bounded at a distance of 2 cm. with a red line which nicks inward slightly towards the end of each arm of the cross. The lower 1/3 of the design is very faded. Height c. 20 cm.

Okabi or Namani: a design put onto a cape for some ceremonies.

2. A red line Greek cross surrounded by a white line. Arms 15 cm. (vertical) and 18 cm.; width of red and white lines each 2 cm.

Carrado'a: the design used on the laplaps of medical orderlies.

¹ Note that in White and White, 1964, Fig. 12 is wrongly attributed to Batari.

3. Human face, arms and upper part of trunk in red line, total length 25 cm. The inverted sub-triangular face contains a central vertical 'nose', four 'eyes', one below the other on each side of the nose. An arm is raised on each side of the head, with the hands at forehead level. From the right arm a zigzag line runs down and to the right for 10 cm. The upper part of the body is painted in red wash. Above the head runs a horizontal line with five vertical strokes down to the head.

Lefatata: a headdress (on a man).

4. A left hand stencil made by blowing red paint against a hand held onto the rock. This stencil is superimposed on a white curved line.

5. A negative cross with a series of three white outlines round it. While the inner line has sharp corners, the outer lines do not. 16 x 15 cm.

Aurara or Tamema: the feathers of a white cockatoo found in the Markham R. valley. The feathers are traded into this area and used during ceremonies.

6. A large red M with outer arms curving smoothly into the top. 12 x 8 cm. This partly overlies 5.

Not identified.

7. A horizontal red line length 24 cm. with nine short vertical strokes, approximately equally spaced along the lower side. This design is partly faded.

Not identified.

8. A complex pattern of red lines, based on a cross. Not now decipherable owing to the removal of much of the design by vertical scratching.

9. Right hand stencil in red paint.

10. Semi-human figure in red line. Sub-triangular head with vertical nose and two eyes, stick-like body with horizontal arms and bent legs. Testicles clearly visible between legs. Ten small red rays run out from the head. Immediately above these is a large red U with inside it a white E opening downwards. 35 x 15 cm. overall.

Naida: a small water beetle.

11. Lizard-like figure in red wash, with small oval head and a 20 cm. long tail. Three digits can be seen on each limb and each limb is bent at the elbow. 45 x 25 cm. Over the top of this design, which is oriented head uppermost, is placed an inverted yellow U.

Evari: a lizard which lives on the edges of streams.

12. A crescent in red wash, internally U-shaped, externally nearly circular. The distance between the arms is about 10 cm., but the size could not be measured.

Not identified.

13. Similar design to 12, but in yellow wash.

14. Vertically oriented stick-figure in red. Small round head, straight body and 'tail', with forelimbs bent up and hindlimbs bent down. Three digits on the end of each limb. Length c. 30 cm.

Wanti: a large black ?frog which lives in the bush and which people eat.

15. About a dozen short vertical strokes in red.

Mara'o: the noise of two people calling to each other.

16. Five positive hand prints in red. Three are right hands, the other two are not determinable. The paintings have been made by placing the palm in liquid paint and then pressing it onto the rock.¹

Ident.: the hand-print of Sirebo, local tambaran.

17. A stencil of a left hand in red.

18. A Greek cross in yellow: the vertical arms are positive but the horizontal arms are negative and shown simply in outline. Approx. 20 x 20 cm. The paint used for this is called murika; identification not given.

19. A positive print of a left hand, in red. This is the only clear red painting within Batari cave itself and is on the back wall between the two northern entrances, about 9 inches from the ground.

The hand print of Sirebo, the tambaran.

20. A positive red cross (18 x 10 cm.) with one outline in red drawn around about 1.5 cm. away. Around the whole is then a complex irregular curvi-linear pattern in red. Overall c. 30 x 35 cm.

Tabu: a small twisted tree. Sirebo is said to have made this picture.

21. A vertical red line ending at the top in a small natural hole in the rock. The line is crossed by three

¹

White and White, 1964, Fig. 7.

horizontal red bars, 6-8 cm. long at 6, 10 and 14 cm. from the top. Length 20 cm.

Waiha: a poisonous snake.

22. Vertical red line, 40 cm. long, with small red dot at the top. Crossed by two pairs of 'limbs', the upper pair with left end turned down and right turned up, the lower pair with both ends turned down. Width c. 15 cm.

23. An irregular squiggle in red.

24. A right-hand stencil in red.

25. Left-hand stencil in red. The fingers are widely splayed.

26. A complex design in red line, heavily scratched out with vertical scratches. Basically it appears to be a W shape surrounded by two red outlines.¹

A self-portrait of Sirebo.

27. Basically a broad-based U shape with both ends curved around and in on themselves. Red line. Inside along the base of the U run a series of ten red dots. 15 x 25 cm.

Tamata: a sea shell (?gold-lip shell).

28. Two opposed brackets in red line [thus:)(] surrounded by three red-line rectangles. Each side of each rectangle is bent inwards while from the outermost run 40 short rays spaced equally. 22 x 22 cm.

Bihuunta: a frog.

¹

See White and White, 1964, Fig. 11, wrongly attributed to Bari'ira site.

29. Positive red Greek cross surrounded by two outlines in red. The inner outline follows the cross quite closely but the outer is little more than a square with slightly concave sides. 15 x 15 cm.

Tiroga: a bird.

30. Right-hand stencil in red.

31. Two pairs of circles, each vertical pair being joined by outcurving brackets in red line. The whole surrounded by a red line indented towards either end of each bracket and at top and base of the design. 23 x 13 cm.

Omepapanti: a man's genital covering.

32. Red-line triangle surmounted by a lozenge with a horizontal red line on top of the lozenge. 22 x 18 cm.

Caratuhi: a 'tanket' plant.

33. Similar to 29, but with cross surrounded by three red lines. 21 x 18 cm.

Kemuraumura: a tree, like bamboo.

34. Red positive hand-print, very faded.

2. Koyagu hill

1) Conventions and notes

1. The numbering of the designs runs approximately west to east along the shelter wall.

2. Vertical measurements are given first in all cases.

3. Reference to the internal divisions of circular designs and the relative positions of paintings is given through the device of a 12-hour clock face.

4. The orthography of the native names has been given in most cases by Mr J. Prentice and Dr D. Laycock of Department of Anthropology (Linguistics), Australian National University.

5. It is impossible to say which particular sarumane design Dr Wagner is referring to in his sketches. The design given is similar to my Class 1 i) (above).

2) Kafiavana

1. Sideways oriented white-outline rectangle with black-line isosceles triangle applied with base to the left end. Rectangle 24 x 54 cm.; triangle 24 x 30 cm. Rectangle is divided by two white diagonals which do not quite meet at centre. Upper and lower quarters are black-filled; right and left are partly filled with yellow-brown, though a chevron of unpainted rock is left between the yellow-brown filling and white lines. The short ends of the rectangle are marked in black as well as white. Base of \triangle and left end rectangle partly eroded by water trickle.

Position: centre is 2.6 m. above ground and c. 1 m. west of west side of excavation.

Dedekopa: a bird which lives in the rain forest; now found only towards Okapa. Possibly a Bird of Paradise. Cf. Wagner's interpretation of 'nenekopa': a black bird, wings alone shown.

Plate 9-6.

2. White circle with five white spokes drawn to off-centre white axle. Segments coloured alternate black and red, with two black ones beside each other. Red segments at about 12-2 o'clock and 7-9 o'clock. 26 x 26 cm.

Position: top is about 15 cm. below 1.

Sarumane: named after a hornbill.

Plate 9-6.

3. White circle, slightly flattened at top and bottom with 4 white spokes drawn to central white circle (axle). Axle has white dot in centre. Top and base segments, yellow-brown, occupy about 50° of circle each; right and left segments, black, about 130° each. 15 x 21 cm.

Position: top is about 5 cm. below and 10 cm. to east (right) of 2.

Sarumane.

4. Two concentric white circles with spokes at 4 and 5 o'clock. No segments coloured. Painting is in area of water trickle. 13 x 11 cm.

Position: top is 32 cm. below bottom left corner of 1.

Sarumane.

5. Three-quarters of a black circle formed by more than 24 short strokes pointing towards a central point. Top is open. Occasional white strokes appear between the black ones. 26 x 23 cm.

Position: 15 cm. to left of 5 and at slightly higher level.

Unknown: informants claimed that the design had been partly washed off, and they could no longer tell what it had been.

6. Hourglass design in white outline (double lines at either side) with some black filling and two white strokes from top to centre. 20 x 8 cm.

Position: c. 20 cm. to left of 5.

Korekove(na): a flying insect which lives in trees. Cf. Wagner: 'an insect which sleeps in caves and which we eat'.

7. Five-pointed star, made up of faint white-line circle, with 5 white-line triangular points on outer side. Each triangle is black-filled, but centre circle is unpainted (or eroded). Painting is entirely within water trickle area. 32 x 22 cm.

Position: centre is 15 cm. below and 28 cm. to the left of base of 3.

Ikaga: moon. Wagner: 'Kokoporana' - a butterfly.

8. White-line circle, unpainted centre, with 8 white rays around the outside. 14 x 17 cm.

Position: 50 cm. to left of 3.

Huva(na): a frog as a man standing above it and looking down would see it.

9. White-line circle with two white vertical lines dividing it internally into about thirds. Right and left are black-painted, the centre third is red. 16 x 19 cm.

Position: about 50 cm. below 8; about 1.1 m. below and 50 cm. to left of 1.

Sarumane.

10. White-line circle. Within this a red cross through the centre. The arms are oriented at 3, 6, 9 and 12 o'clock, and broaden slightly towards the circumference. The other areas filled by 4 black segments, approx. triangular in shape. Within area of water trickle. 23 x 26 cm.

Position: centre is 28 cm. below centre of 7, and circle edge is about 2 cm. below lowest point of triangular rays.

Sarumane.

11. Similar to 9, but the vertical dividing lines bend slightly towards the centre of the design. 21 x 26 cm.

Position: 25 cm. to right and 20 cm. below 10.

Sarumane.

12. White-line circle with 4 white spokes meeting at centre-point. Upper and lower segments red. Other 2 black. Rather faded. 16 x 18 cm.

Position: 22 cm. below 11, 10 cm. to right of it.

Sarumane.

13. As 12, but side segments each about 150° , red each 30° . 18 x 23 cm.

Later scrawls of charcoal over this picture.

Position: directly to the right of 11, with rims of circle touching at one point.

Sarumane.

14. White circle, white centre axle. Red segments at 3 and 9 o'clock with apex at outer side of axle, each about 20° . Twelve and 6 o'clock segments also in red, but run through the axle and have been rubbed over with black charcoal (?) (not paint) to give the effect of a bi-concave black bar down the centre of the design. The four interleaving segments (each about 70°) are in blue-grey. Round the outside are at least 26 white rays, each c. 5 cm. long. Some rays are obscured or possibly missing. At about 5 o'clock no. 15 is superimposed on a corner of no. 14. 26 x 30 cm.

Position: centre is c. 15 cm. to right and 22 cm. above centre of 13.

Sarumane.

15. White circle with 25 white rays (length 1.5-5 cm.) round the outside. Immediately within the circle is a black circle 2-3 cm. wide and the inner part is then filled with red. 20 x 24 cm. (from ray tip to ray tip).

Position: at 4 o'clock and adjacent to 14.

Yege (Zege): the sun.

16. Two concentric black circles (diam. 10 and 6 cm.). Inner one filled with red; space between circles filled with alternate black and white strokes (20 of each) with many of the white ones faded; around the outside 40 rays each c. 1.5 cm. long. 13 x 13 cm.

Position: centre is 18 cm. below 15.

Kenevi: a star.

17. Black circle with black segments to, and 3 cm. wide over, centre at 12-2, 3-4, 5-7 and 9-11 o'clock. Black segments join at the centre (width 3 cm.). Intervening segments, which do not reach centre, are in red. 26 x 27 cm.

Position: about 25 cm. to left and 20 cm. below 16.

Sarumane.

18. White circle with solid white centre axle. Three black segments at 11-2, 3-5 and 7-8 o'clock. Three red segments in intervening spaces. Some rays in alternate red and white round the outside. 19 x 21 cm.

Position: c. 20 cm. below and 20 cm. to right of 17.

Sarumane.

19. A red-line elongated oval 26 cm. long, pointed at the base, with a 6 cm. diameter red-line circle joined to the top end. Inside the oval is a black line and the body is sketchily filled with white. On the outside of the right-hand side of the oval is a white line. 32 x 11 cm.

Position: centre of red circle is 14 cm. to the right of 7 and figure runs down beside this and 10.

Koguna: a duck (pidgin: pato). Possibly Anas sp., found in the Highlands.

20. Vertically elongated circle outlined in black. Upper and lower segments (centred on 12 and 6 o'clock), which do not quite reach the centre, are in black (each

about 45°); the side segments, which meet at the centre, are in greyish-white. 26 x 15 cm.

Position: The lower edge of the bottom black segment is superposed on 14. Centre is 24 cm. above centre of 14.

Dedekopa: a bird which lives in the rain forest. Possibly a Bird of Paradise.

20A. Faint white-line circle with large (9 cm. diam.) central red axle outlined in white. Between axle and circle 4 black and 4 red segments are visible, the black at about 2-3, 5-6, 7-9, 10-12 o'clock. Approx. 19 x 20 cm.

Position: The top left quadrant of this picture lies under 3 and the whole is quite faint.

Sarumane.

21. Black-line elliptical oval lined on outside with white, about 14 cm. long, filled in with yellow-brown. At top a small round yellow-brown 'head' outlined in white. From the base a vertical black line runs 16 cm. down and then bends up at 10 o'clock for 6 cm. and then vertically down for 8 cm. (i.e. as a stick-like leg might be drawn). 33 x 5 cm. (at widest part of ellipse).

Position: 'Head' is 30 cm. to right of left hand end of 1.

Dogorom(na): a lizard, c. 20-25 cm. long, which lives in trees. Cf. Wagner: 'Yakorokorofabe' - an edible insect which lives in trees.

22. Series of 4 white-line lozenges joined vertically end to end; filling alternately yellow-brown and black, with the two yellow-brown lozenges having a

black lozenge immediately inside the white outline. From each side point of each lozenge runs a small (4-5 cm.) yellow-brown 'finger', outlined in white, and these are also found at the 3 points where the lozenges join, making a total of 7 each side. Around the top point is a series of 4 similar 'fingers'. This design is wholly in a rain-trickle area and is much eroded. Approx. 52 x 10 cm.

Position: 15 cm. to right of 21.

Korikova: a flying insect which lives in trees. Cf. Wagner: Lobisai - an insect that sleeps in the sun.

22A. A faint series of 2 red and 3 white parallel lines forming parts of 4 lozenges joined at the side. The two centre ones are complete, the one on the left has the top half only, and the other has the top left section only. 20 x 40 cm. approx?

Position: starts 28 cm. to right of centre of 20.

?Neenbege - a pulpul (grass skirt) [author's orthography].

23. This looks most like a stylised human figure with rounded oval 'head', pinched-in 'neck', elliptical 'trunk', pinched in at the base of the 'trunk' and the start of a third oval to indicate the 'legs'. The overall design is outlined (from the outside) in white, black, white and red. The 'head', c. 15 cm. long, is filled with red, the 'body', c. 26 cm. long, with blue-grey. The inner red lines meet at the base of the body and are continued, one centrally between the 'legs' and the other on the outside of the right 'leg' outline. A black line running from the top of the 'head' down about 2/3 of its length suggests a nose. 52 x 13 cm.

Position: head is on a level with and about 60 cm. to right of 15.

Bat'e: a human baby.

Plate 9-7.

24. White circle with solid white axle. Three black segments 12-2, 5-7.30, 9.30-10.30 o'clock and three red segments. Three white lines, approximately parallel, are painted from the central axle to the outer circle in the centre of the 5-7.30 o'clock black segment. 23 x 23 cm.

Position: centre is 28 cm. to left of centre of 'trunk' of 23.

Sarumane.

25. White-line circle, with red axle outlined in white. Four black segments occur at 11-1, 2-3, 5-7 and 8-10 o'clock; between them are red segments. Four thin parallel white lines run down top and bottom black segments (but they are not continuous lines), one vertically divides the left black segment and three vertically divide the right black segment. A charcoal circle has been scrawled over the top of the picture approximately around the outer white circle. 22 x 23 cm.

Position: centre is 12 cm. to left and 18 cm. below 24. The white outer circles of these two designs merge at about 1.30 o'clock on 25.

Sarumane.

25A. Two solid black triangles, placed apex to apex, outlined at sides and apices by white. Upper triangle 11-1, lower 4.30-7.30 o'clock. One each of the outer

sides of the upper triangle are 9 short white rays.
18 x 9 cm. with upper triangle 13 cm. long.

Position: junction of apices 24 cm. to the right of
25.

Name not collected.

26. White-line circle, off-centre white-line axle
and eight white spokes dividing red from black segments.
Black segments occur at 10.30-1.30, 3-4, 6-7, 8-9.30
o'clock, and red between these. 26 x 27 cm.

Position: 2 m. above ground surface and 1.2 m. east
(to the right) of 3.

Sarumane.

27. White-line circle, solid white axle. Four red
and four blue-grey segments with some suggestion that these
are separated from each other with black spokes. Red
segments are at 12-1, 3-4, 6-7 and 9-10 o'clock, and blue-
grey lie between these. Round the outside of the circle
are 67 very short (max. 1.5 cm.) red rays. 27 x 34 cm.

Position: centre is 60 cm. below 26.

Sarumane.

28. White-line circle 3 cm. diameter; outside this a
black circle, then, with a 2 cm. gap, another black
circle, not visible from 10 to 3 o'clock. White circle is
filled with red. From the lower part of the inner black
circle radiate 14 thin white rays c. 4 cm. long, while
from the upper part radiate 10 rather thicker rays.
10 x 12 cm.

Position: centre is 15 cm. to right and 25 cm. below 27.

Kőnevi: a star. Cf. Wagner: kenebi - a star.

29. White-line circle, solid white axle, and six white spokes. Alternate red and black segments, with black at 1-3, 6-8 and 9-11 o'clock. 23 x 30 cm.

Position: centre is 50 cm. below 27.

Sarumane.

30. White-line circle, axle solid white with reddish tinge. Alternate black and red segments or spokes at 3, 6, 9 and 12 o'clock, all except the last being thin and bar-shaped rather than segments. 22 x 24 cm.

Position: centre is 30 cm. to right and 10 cm. below 29.

Sarumane.

30A. Horizontally aligned series of triangles placed side by side base to apex: six have the apex at the top and the five between them at the bottom. The colours are as follows, left to right: red, ?black, red, ?blank, red, black, red outline and black fill, black, white outline and red fill, black, red outline and black fill. 15 x 50 cm.

Position: left hand triangle is placed just above right quadrant of 27.

?Fepe: a folded and bent fibre rope used for making a belt.

31. White-line circle, white-line axle, without central colour filling. Axle is off-centre, towards the

right. Six white spokes separate black and yellow-brown segments. The black segments are at 2-3, 6-8 and 10-12 o'clock. 22 x 28 cm.

Position: centre is 40 cm. to right and 6 cm. below centre of 27.

Sarumane.

Plate 9-9 (top left).

32. Irregular white-line circle, white-line axle (5 cm. diam.) with red centre. Black line around white axle and black spokes at 11, 1 and 5 o'clock. One o'clock spoke runs across a red segment. Segments are alternate red and blue-grey, with red ones at 11-2 and 5-7 o'clock. Round the outside of the circle are 96 short (1-2 cm.) alternate red and white rays; some more of these seem to be missing in the lower right quadrant. 23 x 21 cm.

Position: centre is 29 cm. to right of centre of 31.

Sarumane

Plate 9-9 (top right).

33. Very faded white-line circle and white axle. It is not clear whether the axle was solid colour. Solid-colour segments are alternate red and blue-grey, with red ones at 11-1, 4.30-6, and 7-8 o'clock. Painting 34 overlies the top right part of this design. 25 x 27 cm.

Position: centre is 27 cm. below and 3 cm. to left of centre of 32.

Sarumane.

34. Black-line circle with an equal-armed cross in black outline inside. The horizontal arms of the cross

end 2 cm. from the circle but the vertical arms join it. The width of each arm is c. 2 cm. This design appears to be drawn in paint, not charcoal. 21 x 16 cm.

Position: centre of cross is 12 cm. to right and 20 cm. below centre of 31.

Sekaseka: the leaf of a plant which grows in the water; the leaf rests on the surface of the water as with a waterlily.

Plate 9-9 (centre left).

35. White-line circle 6 cm. in diam. with 9 irregularly spaced white rays 3-4 cm. long coming from it. All appears to be drawn on a solid black circular background. 17 x 17 cm.

Position: centre of circle is 5 cm. to right and 22 cm. below 32.

Kēnevi: a star.

Plate 9-9 (centre).

36. A vertically oriented black-line oval, 15 cm. long, pointed at the basal end, where there is a small round yellow-brown dot, outlined in black. Below this dot, at 5 and 7 o'clock the black lines continue for about 8 cm. Within the oval, towards the base is a vertically oriented oval red dot 3 cm. long outlined in white and black. 23 x 7 cm.

Position: yellow-brown dot is 20 cm. to the right of and 15 cm. below centre of 33.

Okera: a freshwater crab or crayfish.

Plate 9-9 (bottom).

37. Looks like a very schematic human figure in red line drawn over with dry black pigment. Vertically oriented, it comprises an oval 'head' 5 cm. long and a straight stick-like 'body' 14 cm. long. From the junction of 'head' and 'body' project 'arms' for 7 cm. on either side and these are crossed at right angles near their extremity by another short stroke. About 5 cm. lower down the body two 'legs' are projected at 8 and 4 o'clock and these also are each crossed by a short stroke at right angles. 19 x 16 cm. This design is partly superposed on a pair of white diagonals on a black background.

Position: junction of 'head' and 'body' is 9 cm. to the right of and 15 cm. below yellow-brown dot of 36.

Topic: a large stick insect which lives in yar trees.

38. One and two half lozenges drawn in outline joined side-point to side-point. The main lines are all drawn in red, sometimes with two parallel lines, but 3 sides, two inside the main lozenge and one in the left half-lozenge are also drawn in white line. Approx. 30 x 40 cm.

Position: base point of main lozenge is 30 cm. above and 10 cm. to right of centre of 32.

Informants did not agree. The alternatives of korikova and huva(na) were given.

39. Vertically oriented schematic human figure in red and two white lines. Small round 'head', 'neck' 6 cm. long, asymmetrical oval 'body' c. 33 cm. long, 'legs' at 8 and 4 o'clock continuing a further 9 cm. 'Head' and 'body' ovals lightly filled with black. 60 x 16 cm. approx.

Position: 'head' is 30 cm. to the right of and 60 cm. above centre of 32.

Kayave: pandanus nut (pidgin: mareta).

40. White circle, white-line axle with red centre. Four white spokes at 9.30, 1.30, 4 and 7 o'clock. Alternate red and black segments, but the black segments run from 1 to 4 and 7-10 o'clock, i.e. they are not contained by the spokes as is the case in most others of this type. The spokes are not painted over the solid colour segments but are applied to bare rock, so that their 'misplacement' cannot be regarded as a mistake. Approx. 18 x 20 cm.

Position: centre is 38 cm. to right of 'head' of 39.

Sarumane.

Plate 9-10.

41. White-line circle divided into segments by two white diagonal spokes. The top (11-1 o'clock) and bottom (5-7 o'clock) segments are red, the side segments black. The whole picture is very faded. 24 x 22 cm. approx.

Position: centre is 24 cm. below and 10 cm. to the left of centre of 40.

Dedekopa: a bird which lives in the rain forest.

42. White-line circle with a symmetrical solid-colour red cross inside it. The arms of the cross are oriented at 11, 2, 5 and 8 o'clock. 12 x 12 cm.

Position: left side of circle almost touches base of right 'leg' of 39.

Sarumane.

43. Red dot, 3 cm. diameter surrounded by, consecutively, two white and two black circles. From the outer black circle radiate 22 white rays 4 cm. long; at the top quarter of the circle these alternate with 5 black rays. 14 x 14 cm.

Position: red dot is 25 cm. to right and 8 cm. below centre of cross of 42.

Kšnevi: a star.

44. Design similar to 30A; here four triangles have apex at the top and five at the base. As with 30A the apex-down triangles are black, the others are alternately (l. to r.) white and red. c. 10 cm. x 50 cm.

Position: base of right-hand black triangle almost touches 43 at 7 o'clock.

Korikova. Cf. Wagner: Korikofa.

Plate 9-9 (centre right).

45. Two rather flat isosceles triangles with bases slightly concave, placed with bases vertical and apices towards each other, though not quite touching. Base lines are drawn in black, the other two sides in red. Both triangles are filled with white. Between the triangles and out as far as a line drawn between each pair of bases is filled with blue-grey. The overall boundaries of the design are thus rectangular. Height of each triangle (base to apex) c. 8 cm. Overall 25 x 18 cm.

Position: junction of two apices is 58 cm. below and 8 cm. to right of centre of cross of 42.

Dedekopa.

46. Vertically oriented lenticular shape drawn in line, with top slightly open and base pointed. From the outside the shape is composed of four lines, namely black, red, white and red. Within the design are suggestions of several line-drawings of lenses decreasing in size, but these are not clear. Running in a horizontal line just above the upper opening is a series of 17 vertical red strokes each c. 2 cm. long, c. 2 cm. apart. The seventh from left of these projects slightly into the open top of the lenticular design. Lenticular shape 38 x 15 cm. app.; horizontal line 42 cm. long.

Position: centre of lens is 12 cm. to the right of centre of 43.

Yegetutunana: a bunch of bananas viewed from below. This has yellow rays like the sun, and the stem of the word (yege) is the same. Cf. Wagner: Kaiabe - pandanus nut.

47. Circular design, not outlined, of alternate red and black segments separated by white spokes radiating from a white-line central axle. Centre of axle not coloured. Red segments are at 11-1 and 5-7 o'clock. Whole design rather faded. 15 x 18 cm.

Position: centre is c. 60 cm. below and 30 cm. to the left of centre of 45.

Sarumane.

48. Naturalistic bird facing left drawn in charcoal outline, with white filling in the body. The head is in outline except for a charcoal eye and there are two charcoal line legs. A few charcoal streaks indicate tail feathers. Height from tail feathers to claws 27 cm. and length from beak tip to tail feathers 30 cm.

Position: head is 25 cm. to right and 10 cm. above centre of 47.

Hēgkuvaga: a biggish bird which eats fruit from trees.

Plate 9-8.

49. White-line circle with central axle composed of two concentric white circles 1 cm. apart, the space between them blank, the inner one filled with red. There are six alternate red and black segments, five of which are separated by white spokes. There is no spoke at 7 o'clock. The red segments are at 12-1, 5-6 and 7-9 o'clock. 24 x 28 cm. approx.

Position: centre is 2.5 m. above ground and positioned approximately over F/G line of excavation. This puts it slightly to the left of and about 60 cm. above 40.

Sarumane.

50. Design very similar to 45, except that the apices of the triangles join and the heavy black colour filling the triangles is carried across from one to the other. The triangles are outlined in white and the filling to make up the rectangular shape is yellow-brown (?). 62 x 21 cm. approx.

Position: junction of apices is 18 cm. below and 32 cm. to the right of centre of 49.

Seta(na): a bird with a very long tail which men use for decoration. Now found only in bush country towards Okapa. Possibly a Bird of Paradise. Cf. Wagner: Dedekopa - a black bird, wings alone depicted.

51. A small white vertically oriented oval surrounded by a black then a white line, the whole looking rather like a medallion. From either side of this run nearly horizontal red lines with white lines parallel to them both above and below. Approx. 5 x 30 cm.

Position: centre of oval is 50 cm. below and 10 cm. to left of centre of 49.

Kisereyave: a tiny bird which nests in stone. Possibly a swiftlet (Collocalia sp.).

52. A vertical series of 16 closely adjacent chevrons open at the top increasing in size down to the 10th, then decreasing. Colours (from the top) alternately white, red and black, ending in white. Opposed slightly asymmetrically to the base of the lowest chevron is a series of 5, opening downwards, and decreasing in size. The colours of these (from the top) are black, white and red. One white chevron is placed on the left side, with the apex to the junction of top and bottom series. A white border line is drawn down either side of the design and from the left one 12 horizontal strokes run out a few cms. Approx. 55 x 30 cms.

Position: level with, centre 30 cm. to right of junction of apices of 50.

Haveva: a fern leaf. Cf. Wagner: Haipetata, a human rib-cage.

53. The same design as 50, but without the red paint filling up the inter-triangular positions. The impression is one of a sideways oriented hourglass. Approx. 60 x 20 cm.

Position: junction of apices 60 cms to right of 50.

Seta: a bird with a very long tail, now found only towards Okapa.

54. White circle, solid white axle. From the axle run 11 red spokes, reasonably regularly spaced. The intervening segments are all black except one, at 6 o'clock, which seems to be painted in blue-grey. About 20 x 20 cm.

Position: about 1.3 m. above ground, over F/G line of excavation.

Yege: the sun.

55. Very faded circle composed of alternate black and red segments; red segments at 1-4 and 7-10 o'clock. 16 x 18 cm.

Position: c. 80 cm. below and 20 cm. to right of junction of apices of 50.

Sarumane.

56. White circle with red-dot axle. Thick black spokes (or thin segments) at 2, 5, 7 and 10 o'clock. The main segments are in red. The whole very faded. 24 x 20 cm.

Position: about 80 cm. above ground over east edge of excavation.

Sarumane.

57. Irregular white circle. No axle, but four thin red segments oriented at 11, 3, 5, 9 o'clock, meet at the centre point. The intervening segments are in blue-grey. 20 x 22 cm.

Position: about 20 cm. above and 20 cm. to right of 56.

Sarumane.

58. Very faded circle of two red segments (at 10-1 and 4-7 o'clock) and two black segments. c. 18 x 22 cm.

Position: just above 57.

Sarumane.

59. Three zigzags in red-line running horizontally and approximately parallel to each other. Both upper and lower bend slightly towards the centre zigzag. 15 x 13 cm.

Position: 20 cm. to the right of 57.

Sarumane.

60. Two narrow isosceles triangles, the lower base towards ground, the upper inverted to join apices with the lower, thus forming an hourglass shape. Both outlined at the sides in white, but neither base is drawn in. The insides of the triangles are coloured black. 33 x 16 cm.

Position: c. 75 cm. to the right of and 75 cm. below centre of 53.

Yauga: an hourglass drum.

61. Red line circle, centre not coloured, with 9 red-line triangles forming rays on the outside of the circle. 10 x 10 cm.

Position: about 30 cm. below 60.

Beniva: the seeds (fruit) of the hoop pine (*Araucaria cunninghamii*), (kindly identified by Mr D. Loh, D.A.S.F., Kainantu).

62. Very faded red-line circle with 11 straight red rays coming from it. Cf. no. 8. 7 x 7 cm.

Position: about 15 cm. below and 20 cm. to right of 61.

Kénevi: a star.

The paintings numbered 63-73 are found on the next major rock face to the right, parallel with and about 1 m. forward of the main shelter wall. There are no paintings on the face at right angles to the main panel.

63. White-line circle with solid red axle. Red segments occur at 2-4, 6.30-8 and 10-11 o'clock. These are bordered by white spokes which do not run directly adjacent to the red segments but leave a small gap between spoke and red paint. The other segments seem to be unpainted. 21 x 21 cm.

Position: 1.6 m. above ground, almost on the left corner of the second rock face which runs to the east from F2/3 approx.

Sarumane.

64. Faded white-line circle, solid red axle with faded white circle round it. Alternate black and red segments with red segments at 3.30-5, 6.30-8 and 11-1 o'clock. The points of the red segments do not quite reach the axle. 25 x 22 cm.

Position: c. 30 cm. below 63.

Sarumane.

65. White-line circle, solid white axle with 4 white spokes. Alternate red and black segments with red

segments at 11-1 and 5-7 o'clock. From the outer circle run 17 regularly spaced white-line rays, each about 3 cm. long. The whole of this design appears rather coarser or more crudely done than others so far described. 19 x 18 cm.

Position: c. 50 cm. above ground and c. 40 cm. to the right of 63.

Sarumane.

66. White-line circle, white line axle with three double-line white spokes at 2, 6 and 10 o'clock. Segments are not coloured. 18 x 18 cm.

Position: c. 90 cm. above ground and 60 cm. to the right of 65.

Sarumane.

67. White-line circle, white-line axle and white spokes at c. 1, 4, 8 and 10 o'clock. The 4-8 o'clock segment is red, the others may have been black. 13 x 18 cm.

Position: centre is about 30 cm. to right of and 20 cm. below 66.

Sarumane.

68. Very faded white-line circle with red segments at 4-6 and 10-12 o'clock. Other segments black. 21 x 20 cm.

Position: about 30 cm. to right of 67.

Sarumane.

69. Three lozenge shapes ascending from left to right but not quite touching. Each lozenge is set with the long axis vertical. The outlines are in white and the filling in black. Each lozenge is c. 5 x 3 cm. and the whole series stretches over about 18 cm.

Position: just below 66.

Dedekopa.

70. Very irregular and smeared white-line circle with 17 white-line rays visible on the outside of the left hand part of the circle. 17 x 18 cm. approx.

Position: well to the right of other paintings, on a rock surface at right angles to the main face.

Identified as a recent painting drawn by children; a clear distinction was made between this painting, not named, and others, which 'tumbuna yet ol i raitim' [the ancestors drew them].

71. Very faded white-line lozenge next to a small white oval with a vertical stroke down the centre of it. 13 x 7 cm.

Position: below 69.

Huva(na): a frog seen from above.

72. One small white-line circle, concentric with a larger white-line circle. Both very faded.

Position: below and to the left of 68.

Sarumane.

73. Solid white hourglass shape, lower part slightly longer and thinner than upper. On both sides a white line is drawn parallel with the side and about 2 cm. away from

it. From the outside of this many short white horizontal strokes are drawn. 35 x 15 cm.

Position: neck of 'hourglass' is 30 cm. below and 18 cm. to left of centre of 63.

Yauga: an hourglass drum.

3) Patadzavana

1. Solid colour red circle, diam. 10 cm.
2. Two solid red ovals, vertically oriented, each 8 x 4 cm.
3. Red-line circle 8 cm. diam. with 3 red rays on the outer side, at 1, 4 and 7 o'clock. Each ray c. 3 cm. long.
4. Red-line flattened circle, with longer axis (7 cm.) vertical. From the outside run five 3 cm. rays, two on the left side, two on top and one on the right side.
5. Stick figure in red consisting of vertical 'body' 12 cm. long with 'arms' and 'legs' set at right angles to it. The 'arms', each 8 cm. long, cross the 'body' at 4 cm. below its top and the 'legs' each 5 cm. long, cross the 'body' 10 cm. below its top. In the centre of each left limb is a short vertical stroke.
6. Red-line circle (diam. 12 cm.) with symmetrical cross in the middle. The arms of the cross, set at 12, 3, 6 and 9 o'clock, do not quite reach to the circle. From the outside of the circle run 11 regularly spaced rays, each 3-4 cm. long.

7. Very smeared red-line painting which seems to be approximately the same size and design as 6.

8. Inverted U in red, arms 16 cm. long, width 11 cm., with red-line design inside. The design approximates to a Q with tail at the top and a sideways A joined to it below.

9. Black circle 10 cm. diam., with small black-line axle in centre. The body of the circle is divided into alternate black and unpainted segments, with black segments at 1.30-2.30, 4-5, 7-8.30 and 11-12.30 o'clock.

4) Kedawa'aipa

1. Three designs are all made on a section of rock wholly or partly ground before the design was abraded into it. The designs are all vertically oriented lozenges, more or less complete, deeply incised into the rock. Each is about 20 cm. long. Down the long axis another line is abraded in two cases and/or a series of three round holes (2 cases) is produced apparently by drilling.

2. 'Bored' holes. On other parts of the rock there are two pairs and one series of three holes, produced apparently by drilling, but possibly by pecking. Each is 2.5-4 cm. in diameter.

3. On a flat area of rock a lozenge design, similar to those in group 1 has been lightly scratched. Three holes have been scratched along the centre axis.

3. Niobe

Except where paintings were closely adjacent their position was not carefully recorded. The list will

therefore deal with paintings as individual features rather than attempt to relate them spatially. The conventions used in this list follow those used in describing the Kafiavana paintings.

Descriptive list

1. Circle (14 x 16 cm.) formed by four solid colour segments and without circumscribing line. The segments are alternately black and dark red, with red segments at 11.30-2 and 5.30-7.30 o'clock.
2. Black line circle (c. 15 x 20 cm.) with internal symmetrical yellow cross. Each arm of the cross broadens slightly towards the circumference.
3. Black line circle (not meas.) with solid black segments at c. 11-12.30 and 4.30-6 o'clock. Rest of the circle coloured in yellow. A small red V is painted above the upper black segment and the whole design is circumscribed by a black line.
4. Black line circle (c. 22 x 28 cm.) with central black-dot axle. The whole circle appears to be coloured in with yellow but the design is very faded.
5. Black line circle (10 x 12 cm.) with central black axle and 5 black spokes at c. 11, 1, 4, 6 and 9 o'clock. The segments between the spokes are filled with dark red.
6. A double line circle (c. 22 x 20 cm.), the outer light red and the inner black with a small black-line axle. Black spokes radiating from the axle divide the circle into ten segments, coloured alternately red and yellow.

The red segments are at 12-1, 2-3, 5-6, 8-9 and 10-11 o'clock.

Plate 9-12 (scale in inches).

7. A very faded circle with double red line outline and yellow segments. This is so eroded and faded that the form is not clear.

8. Light red-line circle (c. 15 x 15 cm.) with solid red segments, at 12-1, 4-6 and 8-10 o'clock, meeting at the centre. Other segments uncoloured.

9. Same as 8, but red segments at 1-3, 5.30-6.30 and 9-11 o'clock. Not measured.

10. Light red-line circle (c. 10 x 10 cm.) with thick red bar running 2-8 o'clock through the centre.

11. Light red-line circle (c. 12 x 12 cm.) with 6 rays, each c. 5 cm. long extending from left hand half of circle. Right hand side very eroded.

12. Dark red-line circle (c. 12 x 12 cm.) with at least 8 rays (c. 3-5 cm. long) fairly regularly spaced around the outside.

13. Dark red-line irregular circle (c. 14 x 10 cm.) with red dot at centre. From the outside run 9 fairly regularly spaced rays, each c. 5 cm. long.

14. Faded light red-line circle (diam. 6 cm.), with 22 alternately red and black rays, each 5-7 cm. long, occupying the entire outer circumference.

15. Light red-line circle (c. 10 cm. diam.), with red Greek cross inside. The arms of the cross reach to the circumference of the circle.

16. Two concentric light red-line ovals, the outer c. 8 x 12 cm., the inner c. 5 x 9 cm.

17. Light red-line rectangle with rounded corners (c. 9 x 14 cm.) with about 15 rays (each c. 8 cm. long) regularly placed around the outside. The gaps between the lowest 6 rays are filled with black.

18. Faded circle in solid yellow (c. 12 cm. diam.), possibly with a series of small indentations around the circumference.

19. Faded circle in light red-line (c. 8 cm. diam.) with centre filled with yellow. Apparently a series of thick red and black rays run from top and bottom of the circle.

20. Yellow-line lozenge (c. 15 x 10 cm.) with each pair of lines meeting at apex and base and projecting a further 5 cm.

21. Dark red-line circle (c. 20 cm. diam.) with indecipherable internal design in dark red which almost fills the circle. From the outside run 9 short dark red rays, spaced fairly regularly.

22. Yellow-line circle (c. 10 cm. diam.). Three yellow rays at 12, 4 and 5 o'clock are visible on the outside of the circle. The design lies slightly under no. 21.

23. Pair of yellow line circles (c. 8 cm. diam.) placed side by side.

24. Black-line circle (c. 15 cm. diam.). Within this lies another black line circle (c. 6 cm. diam.) filled with yellow.

25. Black-line circle (c. 20 cm. diam.) with right hand part faded. From the outside black rays are visible at 6, 8 and 10 o'clock. Within the circle lies another black circle (c. 10 cm. diam.) entirely filled with yellow. Design 26 is partly superposed on this picture.

26. Light red stick figure lying sideways and c. 30 cm. long. At left end is a small chevron, apex to the figure, while spaced regularly down the body are five pairs of bent 'legs'.

27. Very indistinct series of yellow figures including a vertically barred lozenge and two circles.

28. Yellow-line oval (c. 15 x 23 cm.) with 8 or more irregularly placed and sized rays running from the outside. Within the oval is a smaller (10 x 6 cm.) solid charcoal oval.

Plate 9-13.

29. Charcoal line oval (28 x 15 cm.) with zigzag charcoal design applied round part of the edge, giving the impression of triangular rays. In the centre of the oval lies a small red dot.

Plate 9-13.

30. Solid dark red lozenge with a solid red triangle attached by its apex to each corner. Lozenge 10 x 15 cm., triangles c. 8 cm. base - apex c. 8 cm. across base.

Plate 9-13.

31. Yellow-line oval c. 30 x 15 cm. with yellow line down the centre. From this to the circumference run an irregularly placed series of yellow lines, tending to be

horizontal at the centre and to form chevron patterns at either end.

32. Solid colour yellow patch (c. 18 x 10 cm.) of no very clear form.

33. Schematic figure vertically oriented comprising solid colour, light red oval, surmounted by a circle and then a small triangle, base down. Each of the three figures touch, and their dimensions are 14 x 6 cm., 7 x 7 cm. and 5 x 2 cm. respectively. The two lower figures are outlined in black, yellow and black, with the yellow outline being 1-2 cm. wide. The triangle is not outlined. From each lower corner of the triangle (where it joins the circle) black, yellow and black outlines continue at about the 11 and 1 o'clock orientations.

34. Very faded charcoal circle (c. 12 cm. diam.) with probably an inner yellow-filled charcoal circle.

APPENDIX 10.1

SURFICIAL GEOLOGY OF THE KOSIPE ARCHAEOLOGICAL SITE

Keith A.W. Crook, Department of Geology,
S.G.S., Australian National University.

Abstract

The basaltic bedrock of the Kosipe area is overlain by up to 4 feet of partly weathered volcanic ash, comprising a lower (buried) soil which contains all but one of the artefacts found; a sporadically occurring relatively unweathered ash, and an overlying 2 foot-thick soil similar to the buried soil. These ashes can be correlated with ashes in the vicinity of Mt Lamington.

The artefacts were not emplaced from the present surface. They accumulated before the upper ash was deposited, and probably before the relatively unweathered ash also. The most likely time of their accumulation is during the period when the earliest ash was accumulating, and before it developed a soil profile (i.e. before 15,000 B.P.); however the artefacts may have been emplaced during the hiatus in ash deposition that enabled the old (buried) soil to form (i.e. between 15,000 B.P. and 8,000 B.P.).

Bedrock Geology

The Kosipe district about 50 miles north of Port Moresby has not yet been the object of a reconnaissance geological survey. Observations by the author along the Weitape-Kosipe road, south of Kosipe, and on the Kosipe-Tanipal track northwest from Kosipe along the Ivane River indicate that the oldest rocks are slates and other low grade metamorphics of unknown age with steeply dipping foliation. These are overlain, probably sub-horizontally, by several hundred feet of basic volcanics, probably largely basalt. The volcanics are probably of late Tertiary or early Quaternary age; they are strongly dissected and are not obviously related to any centres of extrusion.

In the immediate vicinity of the Kosipe Roman Catholic Mission the upper part of the basalt unit exhibits a prominent weathering profile. Up to 6 ft of red clayey rotten basalt is exposed along the access road within 150 yards of the Mission. This is overlain by up to 2 ft of yellowish brown (10 YR 5/4 - 10 YR 6/6) clayey soil containing abundant fine buckshot gravel (voidal iron hydroxide concretions formed by pedological processes). The clay (<2 μ) fraction of this soil contains chlorite, poorly crystalline kaolinite and gibbsite.

Surficial Geology

Cuttings beside roads and tracks in the vicinity of Kosipe Mission reveal up to 4 feet of surficial material overlying the weathering profile on the basalt. This surficial deposit contains five distinct and recurring layers. In only a few exposures are all five layers

present, the best exposure being immediately behind Kosipe Church (Plate 1). These surficial deposits are first observed about 1 mile south of Kosipe Mission on the Waitape Road. They also occur for a short distance along the Kosipe-Tanipai track on the north bank of the Ivane River. For the greater part of its length, however, this track is cut into metamorphics, basalt, or deeply weathered polymictic gravels, with abundant rounded slate fragments, which occur on the valley sides high above the present level of the Ivane River.

Details of the five surficial layers in the vicinity of Kosipe Mission are given in Table 1. Their occurrence is largely independent of topography, for they mantle both the crests of spurs extending northwards from the main ridge south of Kosipe, and small gullies between the spurs. The bounding surfaces of all layers except layer 2A are diffuse and are generally approximately parallel to the local contemporary land surface.

This pattern of occurrence precludes accumulation by surface creep. It is best explained by vertical accretion of air-borne material.

Microscopic investigation of samples from each of the layers by the author revealed large quantities of volcanic glass and fresh euhedral pyrogenic minerals - feldspar, hornblende and biotite - of very fine sand to silt size. This assemblage, together with the pattern of occurrence of the layers, indicates that the layers consist of volcanic ash which has undergone weathering subsequent to deposition.

Detailed mineralogical analysis by B.P. Ruxton (pers. comm.) enables these layers to be correlated with ash layers in the vicinity of Mt Lamington (Ruxton, 1966). The suggested correlation is shown in Table 2.

A striking feature of the surficial sequence is the recurrence of dusky brown layers (1 and 3) underlain by yellowish brown layers (2 and 4). Each pair of layers (1 and 2, 3 and 4) is interpreted as a soil profile best referable to the soil group of Humic Brown Clay Soils. The earlier of these soils is buried by later ash falls.

The maximum thickness of both the older and younger soils (26 ins and 24 ins, respectively), suggest that the ash from which each of them formed accumulated as a result of a number of separate falls (Ruxton, 1966, p.62). The occurrence of a buried soil suggests however that there was a cessation of ash deposition for a period sufficiently long for solum differentiation to occur, and that this was followed by rather rapid accretion of further ash and subsequent soil formation. The distinctive ash of layer 2A, which is preserved as lenses in the base of layer 2 (Plate 2) or as tubular fillings within layer 3 (Plate 3) accumulated during this hiatus in ash deposition.

Stratigraphic setting of artefacts

All but one of the artefacts from the vicinity of Kosipe Mission occurred in layers 3 and 4. The recurring relationship between these and the younger layers indicates that little mixing of younger material into layers 3 and 4 can have occurred. The artefacts, then,

cannot have been emplaced from the present land surface. They must have accumulated during the deposition of the ash that formed layers 3 and 4, or during the hiatus in deposition that followed. They appear to have been emplaced before layer 2A accumulated.

The abundance of artefacts in the vicinity of Kosipe Church perhaps suggests accumulation during the earlier ash falls before the formation of the soil profile of layers 3 and 4. On this view the abundance of artefacts would be due to their precipitate abandonment in the face of an ash-fall sufficiently severe to devastate the Kosipe area, and a failure to re-occupy or relocate the area within the span of tribal memory of the location of the site.

Late Quaternary Geological History

Following the weathering of the surface of the ancient basic volcanic rocks, the area became a site of human habitation. Episodic ash falls deriving from Mount Lamington commencing before 20,000 B.P., probably spaced at intervals of a few years, led to the relatively rapid accumulation of more than 2 feet of ash. One of these ash falls may have been sufficiently severe to have caused permanent and sudden abandonment of the vicinity of Kosipe Church by the human inhabitants.

Ash-falls then ceased for a time sufficient for the development of a well differentiated soil profile within the ash, but weathering was quite incomplete.

Volcanic activity was renewed at sometime after 15,000 B.P. and a distinctive but thin ash deposit mantled

the old soil, and filled tubular cavities (? burrows or root holes) within it. Erosion disturbed this layer fairly substantially before it was buried, leaving only sporadic residuals.

A renewal of activity by Mt Lamington after 6,000 B.P. led to the accumulation of a further 2 feet of ash, with concomitant, or more probably subsequent, development of a soil profile. During this time the area was reoccupied by humans, who had, however, no knowledge of the older site of inhabitation. The people of Kosipe village may be the descendants of these late inhabitants.

Literature cited

- | | | |
|--------------|------|--|
| Ruxton, B.P. | 1966 | Correlation and stratigraphy of Dacitic Ash-fall Layers in Northeastern Papua. <u>J. Geol. Soc. Aust.</u> , 13, 41-67. |
|--------------|------|--|

Table 1 : Properties of the Surficial Units

Unit	1	2	2A	3	4
Thickness (max:)	6 ins	15 ins	6 ins	11 ins	16 ins
Colour	10 YR 4/2 dusky yellowish brown.	10 YR 5/4 moderate yellowish brown.	10 YR 7/4 to 10 YR 8/2 grayish to very pale orange.	10 YR 2/2 dusky yellowish brown.	10 YR 5/4 to 10 YR 6/6 moderate yellowish brown to dark yellowish orange.
Texture	sl. clayey silt	silt	v.f. sandy silt	silt	silt
Clay Mineralogy	14Å only	14Å only	14Å _o 11.8Å	14Å only	14Å _o 7.1Å (broad) gibbsite

Table 1 (continued)

Unit	1	2	2A	3	4
Geometry	Blanket, conformable with present land surface.	Blanket, conformable with present land surface.	Lenticular bodies within base of layer 2 (Pl. 2) and tubular bodies within layer 3 (Pl. 3).	Blanket, but with tendency to thicken beneath depressions in landscape (Pl. 4).	Blanket, as 3.
Charcoal	Sporadic, up to $1\frac{1}{2}$ ins long.	Sporadic, up to $1\frac{1}{2}$ ins long.	Nil.	Widely disseminated common, $<\frac{1}{2}$ in. long.	Widely disseminated common, $<\frac{1}{2}$ in. long.
Artefacts	Nil.	One axe-adze.	Nil.	Numerous axe-adzes, mortars etc.	Nil.

Table 2 : Correlation between Kosipe and
Mt Lamington ashes (after Ruxton, pers. comm.)

Kosipe	Mt Lamington	^{14}C (yrs, B.P.)
1	Silimbu Ash	
2	Silumbu Ash	$<6800 \pm 250$
2A	Numba Ash	$>7930 \pm 370$
3	Natanga Ash	$<15000 \pm 500$
4	Sagamasi Ash	$>15000 \pm 500$
		$<20100 \pm 500$
		20100 ± 500



Plate 1 Excavation behind Kosipe church. Corner of cut on right is 69 ins deep.



Plate 2 Lenticular mass of layer 2A in base of layer 2, about 1/2 mile south of Kosipe on Waitape road.

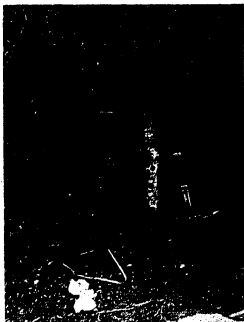


Plate 3 Tubular mass of layer 2A material in layer 3, about 30 yards south of mission gate on Waitape road.



Plate 4 Thickening of layer 3 beneath small gully, about 300 yards south of Kosipe Mission on Waitape road.

APPENDIX 10.2

KOSIPE ASH LAYERS

B.P. Ruxton, Division of Land
Research, C.S.I.R.O.

The fresh ash was probably of very coarse silt or very fine sand in modal diameter and consisted of approximately 60 per cent of crystals of predominantly green hornblende and plagioclase with 40 per cent of micro-vesicular microlitic glass ('groundmass'). The glass is now largely weathered to allophane gel and forms a medium and fine silt fraction.

Mineralogically the ash is identical¹ with that from Mt Lamington.² Mineral counts and radiocarbon dates would support a tentative correlation of

Kosipe layers 1 + 2 with Silimbu ash.

Kosipe base layer 2 (sample 42) with biotite-rich Numba ash.

Kosipe layer 3 with Natanga ash.

Kosipe layer 4 with Sagamasi ash.

1

The completely decisive test will be a chemical analysis of the feldspar, which should be $Ap\ 61 \pm 1$, $An\ 36 \pm 1$, or 3 ± 1 . This will be completed by July, 1967.

2

Ruxton, 1966, pp.41-67.

The spotty nature of the sampling at Kosipe is unfortunate and further work there may reveal evidence of the Dea, Owalama, Gora (?Siurani), and Tabuena layers. The absence of pre-Sagamasi layers is surprising as these make up three-quarters of the ash sequence in the Managalase near Mt Lamington.

The thickness of the ash 80 miles west of Lamington is too great, for in this area the sequence from Silimbu to Sagamasi should not be greater than 30 ins thick. This indicates that there has been local thickening and redistribution of ash layers as would be expected on the side slope of a subordinate ridge. Evidence of redistribution is provided by the patchy discontinuous nature of the Numba Ash at Kosipe.

Literature Cited

- Ruxton, B.P. 1966 'Correlation and Stratigraphy of Dacitic Ash-fall Layers in Northeastern Papua', Journal of the Geological Society of Australia, 13, pp.41-67.

Kosipe Ash

Layer	1	2	3	4
Sample No.	32	33	34	35
Thickness	6"	12"	8"	10"
Depth	6"	15"	Between Layers	46"
Sound Fraction	45.1	37.3	41.1	35.2
	54.9	62.7	58.9	64.8
	64	69	61	50
	33	30	23	50
	3	1	16	4
	r*	r	-	r
	r	r	r	r

* r = rare

Kosipe Ash (continued)

Heavy Fraction	Lamprobolite	4	2	1	2	4
	Opaque	2	5	2	3	9
	Green hornblende	87	87	71	89	85
	Brown hornblende	7	6	3	6	2
	Biotite	-	-	23	-	-
Less Hornblende and Biotite	%	7	7	3	5	13
	Lamprobolite	66	50	75	60	30
	Opaque	34	50	25	40	70
¹⁴ C date (years)			4050 [±] 500 ⁻		16000 [±] 19350 [±]	1200 600
Correlation with Managalase		Silimbu		Numba	Natanga	Saga-masi

Note: Sample 35 is contaminated with some kaolinite and iron concretions from the weathered phyllite below 49".

Batari: Flaked Implement Attributes

Table 1: Number of Planes/Implement (Per cent)

Horizon	Number of Planes				Total No.
	1	2	3	4	
I	67.9	28.5	3.6	-	137
II	78.8	19.2	0.7	1.3	146
III	79.8	18.1	2.1	-	188
IV	73.6	24.3	1.4	0.7	144

Batari
Table 1

Table 2: Number of Edges/Implement (Per cent)

Horizon	No. of Edges									Total No.	Mean No. per Horizon
	1	2	3	4	5	6	7	8	9		
I	29.2	21.2	22.6	11.0	7.3	4.4	1.5	1.5	1.5	137	2.78
II	40.4	27.4	14.4	10.3	5.5	0.7	-	0.7	0.7	146	2.22
III	28.7	36.2	12.8	9.0	6.9	2.7	2.1	1.6	-	188	2.54
IV	29.9	20.8	17.4	13.9	9.0	4.2	0.7	1.4	2.8	144	2.88

Table 3: Weight of all Implements (Per cent)

Horizon	Weight in gm.										Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9		
I	51.1	32.1	9.5	3.7	2.9	0.7	-	3.4	1.4	-	137
II	41.1	28.8	13.0	7.5	4.1	0.7	3.4	1.4	-	-	146
III	40.1	39.9	6.4	6.9	3.7	1.1	0.5	-	0.5	-	188
IV	40.3	34.0	13.2	4.2	6.3	-	1.4	0.7	-	-	144

Tables 4: Weights of Implements in Relation to Planes (Per cent)

Table 4(a): Weight of Implements Used on One Plane

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	60.2	25.8	7.5	3.2	2.2	1.1	-	-	-	93
II	45.4	26.1	13.0	7.0	3.5	0.9	3.5	0.9	-	115
III	42.7	38.0	6.0	7.3	3.3	1.3	0.7	-	0.7	150
IV	50.0	26.4	11.3	4.7	4.7	-	1.9	0.9	-	106

Table 4(b): Weight of Implements Used on Two Planes

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	33.3	48.7	12.8	5.1	-	-	-	-	-	39
II	28.6	42.9	14.3	7.1	3.6	-	3.6	-	-	28
III	32.4	50.0	8.8	2.9	5.9	-	-	-	-	34
IV	14.3	54.3	17.1	2.9	11.4	-	-	-	-	35

Tables 5: Weights of Implements in Relation to Edges (Per cent)

Table 5(a): Weight of Implements with 1 or 2 Edges

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	52.2	30.7	8.2	6.4	1.3	1.3	-	-	-	69
II	51.3	29.8	8.4	3.0	4.6	-	2.1	0.9	-	99
III	48.9	31.9	7.7	6.3	4.3	-	-	-	0.9	122
IV	58.4	23.8	8.0	5.2	2.3	-	1.2	1.2	-	73

Table 5(b): Weight of Implements with More Than Two Edges

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	47.0	35.2	8.8	-	4.4	-	-	-	-	68
II	17.1	29.8	21.3	17.1	4.3	2.1	6.4	2.1	-	47
III	27.3	54.5	3.0	7.6	3.0	3.0	1.5	-	-	66
IV	22.5	45.0	18.3	2.8	9.9	-	2.8	-	-	71

Table 6: Whole/Not Whole Implements, Assessed in Relation to a Particular Edge (Per cent)

Horizon	Whole	Probably Whole	Not Whole	Indeterminate	Total No.
I	10.8	11.0	13.4	64.8	381
II	7.7	13.5	12.3	66.5	325
III	9.4	14.3	14.1	62.3	477
IV	9.9	12.8	11.1	66.3	415

Table 7(a): Raw Material of Implements Treating Each Edge as a Separate Implement (Per cent)

Horizon	Pebble Cortex	Other Cortex	No Cortex	Indet.	Total No.
I	26.5	24.7	42.1	6.7	381
II	34.2	24.6	36.6	4.6	325
III	31.2	24.7	34.8	9.2	477
IV	26.1	24.8	41.0	8.2	415

Table 7(b): Raw Material of Implements, Each Stone Implement Being Counted Once Only (Per cent)

Horizon	Pebble Cortex	Other Cortex	No Cortex	Indet.	Total No.
I	27.0	21.9	43.8	7.3	137
II	32.9	24.0	35.6	7.5	146
III	35.6	21.8	31.4	11.2	188
IV	29.8	20.8	34.9	14.6	144

Table 8(a): Weight of Whole Implements, with 'Whole' Assessed in Relation to Each Edge (Per cent)

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	56.1	14.6	19.5	9.8	-	-	-	-	-	41
II	36.0	40.0	4.0	12.0	-	-	8.0	-	-	25
III	40.0	37.8	4.4	8.9	4.4	4.4	-	-	-	45
IV	39.0	58.5	-	-	2.4	-	-	-	-	41

Table 8(b) : Weight of 'Probably Whole' Implements with
'Probably Whole' Assessed in Relation to Each Edge (Per cent)

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	31.0	33.3	23.8	4.8	7.1	-	-	-	-	42
II	29.6	29.6	18.2	6.8	-	-	15.9	-	-	44
III	23.5	45.6	10.3	10.3	7.4	1.5	-	-	1.5	68
IV	24.5	30.2	32.1	-	11.3	-	1.9	-	-	53

Table 8(c) : Weight of 'Not Whole' Implements, with
'Not Whole' Assessed in Relation to Each Edge (Per cent)

Horizon	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
I	66.7	27.5	5.9	-	-	-	-	-	-	46
II	70.0	15.0	10.0	5.0	-	-	-	-	-	40
III	67.2	22.4	4.5	3.0	-	-	3.0	-	-	67
IV	56.5	19.6	23.9	-	-	-	-	-	-	46

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Tables 8

Table 9(a) : Shape of Whole Implements as Expressed by
Length-Breadth Index (Per cent)

Horizon	L/B Index					Total No.
	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99	
I	78.0	17.1	-	4.9	-	41
II	56.0	20.0	16.0	4.0	-	25
III	73.3	17.8	4.4	4.4	-	45
IV	63.4	26.8	4.9	2.4	2.4	41

Table 9(b) : Shape of Whole Implements as Expressed by
Breadth/Thickness Index (Per cent)

Horizon	B/Th, Index							Total No.
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99	
I	-	-	19.5	7.3	17.1	34.2	22.0	41
II	4.0	8.0	8.0	20.0	24.0	20.0	16.0	25
III	-	2.2	13.3	24.4	31.1	17.8	11.1	45
IV	-	4.9	4.9	7.3	24.4	29.3	29.3	41

Table 10(a) : Shape of Implements not Clearly Broken as Expressed by Length/Breadth Index (Per cent)

Horizon	L/B Index				Not meas.	Total No.
	1-1.49	1.5-1.99	2-2.49	2.5-2.99 >2.99		
I	63.6	27.2	4.6	1.5	1.8	330
II	63.1	21.8	10.2	3.2	0.7	285
III	64.4	27.3	4.9	1.2	0.5	410
IV	55.4	29.3	7.9	2.7	1.1	369

Table 10(b) : Shape of Implements not Clearly Broken as Expressed by Breadth-Thickness Index (Per cent)

Horizon	B/Th. Index						Not meas.	Total No.
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99 >2.99		
I	1.5	11.8	29.7	18.8	18.5	11.8	7.9	330
II	1.1	10.9	30.2	30.5	19.0	3.9	4.6	285
III	-	9.3	22.2	36.6	17.8	11.0	3.2	410
IV	0.3	13.3	27.6	22.8	17.1	7.6	11.4	369

Table 11 : Core and Flake Components of the Industry (Per cent)

Horizon	Core or Lump	Flake	Trimming Flake	Indeterminate	Total No.
I	33.9	55.4	4.2	6.6	381
II	36.5	34.4	7.1	4.6	325
III	24.7	61.8	4.2	9.2	477
IV	36.6	45.3	9.9	8.2	415

Table 12 : Condition of Edges (Per cent)

Horizon	Whole	Probably Whole	Not Whole	Indeterminate	Total No.
I	29.1	37.8	19.2	13.9	381
II	34.5	33.2	18.2	14.2	325
III	34.8	32.7	20.1	12.4	477
IV	38.6	28.4	18.6	14.5	415

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Tables 11-12

Table 13 : Base Types (Per cent)

Horizon	Indeter- minate	Pebble Cortex	Other Cortex	Break	Negative Bulb	Positive Bulb	Not Applicable	Total No.
I	8.9	2.9	6.8	6.3	27.0	41.2	6.8	381
II	9.9	2.2	10.8	8.0	16.8	48.0	2.5	325
III	5.5	1.7	2.7	7.6	25.0	51.4	6.3	477
IV	6.0	3.4	6.5	3.9	29.6	39.5	11.1	415

Table 14 : Preparatory Flaking (Per cent)

Horizon	Unclear	None	Base Struck	Side, End Struck	Not Applicable	Total No.
I	20.0	27.6	44.4	0.5	7.6	381
II	17.2	27.1	52.0	0.3	3.4	325
III	18.0	19.7	56.0	0.6	5.7	477
IV	18.8	20.5	49.2	0.5	11.1	415

Table 15(a) : Shape of Whole Edges (Per cent)

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	31.5	63.1	5.4	-	111
II	21.4	74.1	4.5	-	112
III	26.3	65.1	6.6	-	166
IV	24.4	66.2	9.4	-	160

Table 15(b) : Shape of Probably Whole Edges (Per cent)

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	41.0	52.8	6.3	-	144
II	33.3	59.3	5.6	1.8	108
III	35.3	61.5	3.2	-	156
IV	36.1	55.9	5.1	0.9	118

Table 16(a) : Length of Straight Whole Edges (Per cent)

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-5	>35	
I	37.2	31.4	11.4	8.6	5.7	5.7	-	-	35
II	45.8	33.3	12.5	8.3	-	-	-	-	24
III	25.5	38.3	23.4	6.4	-	2.1	4.3	-	47
IV	25.0	50.0	25.0	-	2.5	-	2.5	-	40

Table 16(b) : Length of Concave Whole Edges (Per cent)

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	19.7	50.7	23.9	4.2	1.4	-	-	-	71
II	6.0	49.4	27.7	13.3	1.2	1.2	-	1.2	83
III	16.6	49.1	29.6	3.7	-	0.9	-	-	108
IV	11.3	56.6	23.6	4.7	1.9	0.9	0.9	-	106

Table 16(c) : Length of Convex Whole Edges (Per cent)

Horizon	Length in mm.							Total No.	
	0-5	6-10	11-15	16-20	21-25	26-30	31-35		>35
I	-	33.3	33.3	33.3	-	-	-	-	6
II	-	-	40.0	40.0	20.0	-	-	-	5
III	-	9.1	43.5	27.3	9.1	9.1	-	-	11
IV	-	20.0	26.7	20.0	20.0	13.3	-	-	15

Table 17 : Indentation Index of Whole Concave Edges (Per cent)

Horizon	Lc/D				Total No.
	<3.3	3.4-4.9	5.0-9.9	10.0-19.9	
I	2.8	9.9	64.8	21.1	71
II	3.6	13.3	61.5	19.3	83
III	3.7	13.0	66.7	16.7	108
IV	0.9	14.2	60.4	22.7	106

Table 18(a) : Indentation Index of all Concave Edges
Not Clearly 'Not Whole' (Per cent)

Horizon	Lc/D				Total No.
	<3.3	3.4-4.9	5.0-9.9	10.0-19.9	
I	1.8	7.7	63.4	26.0	169
II	2.4	10.0	60.0	20.6	170
III	3.0	11.6	64.7	20.8	230
IV	1.1	10.7	66.4	20.8	187
				>19.9	
					1.2
					1.2
					-
					1.1

Table 18(b) : Projection Index of all Convex Edges
Not Clearly 'Not Whole' (Per cent)

Horizon	Lc/D				Total No.
	<3.3	3.4-4.9	5.0-9.9	10.0-19.9	
I	-	-	43.7	50.0	16
II	-	-	38.4	46.2	13
III	-	-	33.3	64.7	17
IV	-	7.4	33.4	44.4	27
				>19.9	
					6.3
					15.4
					-
					14.8

Table 19 : Retouch Type on Edges (Per cent)

Horizon	None	Step Flaking		Other Unifacial Flaking	Bifacial Flaking	Other	Total No.
		Light	Heavy				
I	37.0	37.5	21.3	3.7	0.3	0.3	381
II	22.8	52.3	19.9	4.3	0.3	1.2	325
III	25.4	54.7	16.4	2.9	0.4	0.2	477
IV	35.4	45.3	17.6	1.7	-	-	415

Tables 20 : Angle of Edge on Retouched Edges (Per cent)

Table 20(a) : Light Step Flaking

Horizon	Angle (Degrees)								Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		
I	-	-	1.7	19.6	23.0	30.4	17.6	5.4	1.4	148
II	-	-	1.8	5.9	25.1	35.7	22.2	7.0	2.3	171
III	-	-	2.3	16.1	29.5	28.4	18.4	4.2	1.2	261
IV	-	0.3	2.1	6.4	32.4	33.5	16.5	6.4	2.1	189

Table 20(b) : Heavy Step Flaking

Horizon	Angle (Degrees)							Not meas.	Total No.	
	20-9	30-9	40-9	50-9	60-9	70-9	80-9			90-9
I	-	-	-	11.1	26.0	39.5	17.2	4.9	1.2	82
II	-	-	1.5	13.6	18.2	33.2	24.2	7.6	1.5	66
III	-	-	-	9.0	35.9	33.3	11.5	10.3	-	78
IV	-	-	2.7	8.2	32.9	39.7	12.4	2.7	1.4	74

Table 20(c) : Other Unifacial Flaking

Horizon	Angle (Degrees)							Not meas.	Total No.	
	20-9	30-9	40-9	50-9	60-9	70-9	80-9			90-9
I	-	-	20.0	40.0	13.3	20.0	-	-	6.7	15
II	7.1	-	7.1	28.6	35.7	7.1	14.3	-	-	14
III	-	-	7.1	21.4	35.7	14.3	14.3	-	7.1	14
IV	-	-	28.6	42.9	14.3	14.3	-	-	-	7

Table 21 : Occurrence of Types of Use-Wear (Per cent)

Horizon	None	Chattering	Bifacial	Utilisation	Total No.
I	32.0	56.4	1.1	10.5	381
II	49.2	43.1	0.3	7.4	325
III	39.2	51.8	0.6	8.4	477
IV	33.7	54.0	0.7	11.6	415

Tables 22 : Shape of Use-Wear Types (Per cent)

Table 22(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	66.1	30.7	2.8	0.4	215
II	60.9	35.0	4.3	-	140
III	59.9	37.3	2.8	-	247
IV	59.8	36.2	4.0	-	224

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Tables 21-22

Table 22(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	55.0	25.0	20.0	-	40
II	41.7	25.0	33.3	-	24
III	57.5	22.5	20.0	-	40
IV	43.8	22.9	33.3	-	48

Tables 23 : Shape of Use-Wear, Considering Whole Lengths
of Use-Wear Only (Per cent)

Table 23(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	58.7	40.2	1.1	-	92
II	55.9	42.7	1.5	-	68
III	47.5	49.5	3.0	-	101
IV	47.5	51.5	1.0	-	99

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Tables 22-23

Table 23(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	43.5	39.1	17.4	-	23
II	11.1	44.4	44.4	-	9
III	56.0	16.0	28.0	-	25
IV	32.0	24.0	44.0	-	25

Table 24 : Length of Whole Lengths of Use-Wear (Per cent)

Table 24(a) : 'Chattering'

Horizon	Length in mm.							Total No.	
	1-5	6-10	11-15	16-20	21-25	26-30	31-35		>35
I	60.5	36.5	2.0	1.0	-	-	-	-	104
II	57.0	36.2	4.2	2.7	-	-	-	-	72
III	53.4	30.4	13.3	1.9	1.0	-	-	-	105
IV	47.0	49.0	2.9	-	1.0	-	-	-	102

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Tables 23-24

Table 24(b) : 'Utilisation'

Horizon	Length in mm.								Total No.
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	-	41.5	20.8	16.7	12.5	8.3	-	-	24
II	-	44.5	11.1	33.3	11.1	-	-	-	9
III	12.0	24.0	28.0	20.0	14.0	8.0	4.0	-	25
IV	4.0	12.0	36.0	20.0	12.0	8.0	8.0	-	25

Tables 25 : Indentation Index for Whole, Concave Lengths of Use-Wear

Table 25(a) : 'Chattering'

Horizon	Lc/D						Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9		
I	5.4	16.2	70.3	8.1	-	-	37
II	13.8	24.1	51.7	10.3	-	-	29
III	8.0	16.0	22.0	14.0	-	-	50
IV	2.0	17.7	74.5	5.9	-	-	51

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Tables 24-25

Table 25(b) : 'Utilisation'

Horizon	Lc/D				Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	
I	-	-	44.4	44.4	11.1
II	-	-	50.0	50.0	-
III	-	-	50.0	50.0	-
IV	-	-	16.7	50.0	33.3

Table 26 : Relationship of Retouch Type and Edge Shape on Whole Edges (per cent)

Table 26(a) : Edges Without Retouch

Horizon	Edges Without Retouch			Total No.
	Straight	Concave	Convex	
I	39.7	52.4	7.9	63
II	27.9	44.8	17.2	29
III	48.3	37.9	15.8	58
IV	38.3	41.7	20.0	60

Table 26(b) : Edges with Light Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	23.5	73.5	2.9	-	34
II	16.7	83.3	-	-	60
III	19.5	76.8	3.7	-	82
IV	18.7	78.7	2.7	-	75

Table 26(c) : Edges with Heavy Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	10.0	90.0	-	-	10
II	-	100.0	-	-	16
III	-	100.0	-	-	21
IV	9.5	90.5	-	-	21

Tables 27 : Indentation Index for all Concave Lengths of Use-Wear which are Not 'Clearly Not Whole' (Per cent)

Table 27(a) : 'Chattering'

Horizon	Lc/D					Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9	
I	4.8	17.7	66.1	11.3	-	62
II	9.5	19.0	56.2	14.3	-	42
III	8.8	15.0	62.5	13.8	-	80
IV	2.7	17.3	70.5	5.3	-	75

Table 27(b) : 'Utilisation'

Horizon	Lc/D					Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9	
I	-	-	40.0	50.0	10.0	10
II	-	-	40.0	60.0	-	5
III	-	-	42.9	57.1	-	7
IV	-	9.1	27.3	45.5	18.2	11

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Tables 28 : Projection Index for all Convex Lengths of Use-wear which are Not 'Clearly Not Whole' (Per cent)

Table 28(a) : 'Chattering'

Horizon	Le/D				Total No.
	0-3,3	3,4-4,9	5,0-9,9	10,0-19,9 >19,9	
I	-	-	100,0	-	4
II	-	-	33,4	50,0	6
III	-	-	40,0	60,0	5
IV	-	-	20,0	60,0	5

Table 28(b) : 'Utilisation'

Horizon	Le/D				Total No.
	0-3,3	3,4-4,9	5,0-9,9	10,0-19,9 >19,9	
I	-	-	28,6	57,1	7
II	-	-	33,4	50,0	6
III	-	-	37,5	62,5	8
IV	-	6,3	25,0	50,0	16

Tables 29 : General Angle of Edge with Use-Wear (Per cent)

Table 29(a) : 'Chattering'

Horizon	Angle (Degrees)								Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		
I	-	0.4	2.2	17.0	20.8	33.0	17.0	6.1	3.5	230
II	-	0.7	0.7	6.1	22.4	33.3	26.5	7.5	2.7	147
III	-	0.8	1.6	11.8	26.7	31.0	18.8	5.1	3.7	255
IV	-	1.3	5.2	10.4	24.4	28.7	15.7	10.0	4.4	230

Table 29(b) : 'Utilisation'

Horizon	Angle (Degrees)								Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		
I	7.3	17.1	17.1	26.8	12.2	9.8	4.9	4.9	-	41
II	4.2	12.5	8.3	37.5	8.3	25.0	4.2	-	-	24
III	12.5	12.5	15.0	20.0	20.0	7.5	7.5	2.5	2.5	40
IV	8.2	24.4	16.3	26.5	12.2	6.1	4.1	2.0	-	49

Tables 30 : Use-Wear Types in Relation to Step-flaking Retouch¹ (Per cent)

Table 30(a) : 'Chattering'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	46.5	34.2	19.4	228
II	44.7	44.0	11.2	150
III	37.8	47.7	14.4	243
IV	44.9	42.4	12.6	229

Table 30(b) : 'Utilisation'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	92.8	4.8	2.4	42
II	95.4	4.6	-	22
III	92.0	8.0	-	38
IV	97.9	2.1	-	49

¹Other types of retouch not included because numbers too small. See Table 19.

Tables 31 : Retouch Types in Relation to Use-Wear (Per cent)

Table 31(a) : Light Step Flaking

Horizon	Use-Wear			Total No.
	Chattering	Bifacial	Utilisation	
I	97.4	-	2.6	81
II	98.5	-	1.5	67
III	97.5	-	2.5	129
IV	100.0	-	-	97

Table 31(b) : Heavy Step Flaking

Horizon	Use-Wear			Total No.
	Chattering	Bifacial	Utilisation	
I	95.7	-	4.3	47
II	100.0	-	-	17
III	100.0	-	-	35
IV	100.0	-	-	29

Table 31(c) : No Retouch

Horizon	Use-Year			Total No.
	Chattering	Bifacial	Utilisation	
I	71.4	2.7	25.8	148
II	74.5	1.1	24.4	89
III	71.0	1.6	27.4	129
IV	66.6	2.0	31.4	155

Tables 32 : Implement Thickness in Relation to Retouch Type
Excluding 'Clearly Not Whole' Implements (Per cent)

Table 32(a) : Light Step Flaking

Horizon	Not Meas.	Thickness in mm.							Total No.	
		0-5	6-10	11-15	16-20	21-25	26-30	31-35		36-40
I	-	5.5	41.7	26.0	14.2	8.7	3.2	0.8	-	127
II	0.6	4.5	24.2	32.0	18.3	9.2	7.2	2.0	1.3	153
III	-	7.1	36.6	31.7	13.0	7.1	3.1	0.9	0.4	224
IV	-	6.0	20.2	27.4	26.8	11.9	1.8	3.6	1.8	168

Table 32(b) : Heavy Step Flaking

Horizon	Not Meas.	Thickness in mm.										Total No.
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40		
I	-	4.6	41.5	20.0	21.5	4.6	7.7	-	-	-	-	65
II	-	1.9	17.3	30.8	28.8	15.4	5.8	-	-	-	-	52
III	-	5.1	23.7	50.8	13.5	5.1	1.7	-	-	-	-	59
IV	-	5.1	25.4	30.5	28.8	6.8	1.7	-	1.7	-	-	59

Table 32(c) : No Retouch

Horizon	Not Meas.	Thickness in mm.										Total No.
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40		
I	1.6	19.5	30.5	22.6	14.1	7.8	2.3	0.8	0.8	-	128	
II	-	21.4	12.9	24.3	20.0	11.4	4.3	4.3	-	1.4	70	
III	-	14.4	40.5	16.2	17.1	3.6	1.8	6.3	-	-	111	
IV	1.5	24.1	27.8	27.8	10.2	2.9	3.7	2.2	-	-	137	

Tables 33 : Breadth/Thickness Index in Relation to Retouch (Per cent)

Table 33(a) : Light Step Flaking

Horizon	B/Th. Index							Total No.
	<0.5	0.5-0.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99	
I	-	11.8	32.3	16.5	17.3	11.8	10.3	127
II	0.7	11.1	32.0	28.8	19.6	4.6	3.3	153
III	-	10.3	19.6	38.0	17.9	12.9	1.3	224
IV	0.6	16.8	33.6	23.9	16.2	1.8	7.2	167

Table 33(b) : Heavy Step Flaking

Horizon	B/Th. Index							Total No.
	<0.5	0.5-0.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99	
I	4.6	12.3	35.4	12.3	20.0	13.8	1.5	65
II	-	3.8	34.6	40.4	21.2	-	-	52
III	-	3.4	18.6	50.8	11.9	13.6	1.7	59
IV	-	5.4	40.5	28.4	6.8	10.8	8.1	74

Table 33(c) : No Retouch

Horizon	B/Th. Index							Total No.
	<0.5	0.5-0.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99	
I	1.6	12.5	25.8	24.2	17.2	10.2	8.6	128
II	2.9	15.7	24.3	30.0	14.3	5.7	7.1	70
III	-	10.0	31.5	21.6	23.4	5.4	8.1	111
IV	-	13.1	16.8	18.3	20.4	14.6	16.8	137

Tables 34 : Relation of Retouch Angle and Implement Weight on Implements with Light Step Flaking Excluding 'Clearly Not Whole' Implements (Per cent)

Table 34(a) : Horizon I

Angle (degrees)	Weight in gm									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
30-9										3
40-9	2.4									25
50-9	7.9	9.4	2.4							33
60-9	6.3	15.0	3.2	0.8						39
70-9	9.5	12.6	6.3	0.8						19
80-9	3.2	5.5	3.2	0.8						8
90-9	3.2	1.6	1.6							127

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Table 34(b) : Horizon II

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9										2
40-9		1.3	3.4							8
50-9		6.0	10.1	0.7	1.3	0.7	0.7			37
60-9		8.1	10.1	4.0	5.4	6.7	0.7			57
70-9		6.0	4.7	5.4	3.4	1.3		0.7		34
80-9		0.7	2.7	1.3	2.0	0.7				11
90-9										149

Table 34(c) : Horizon III

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9										5
40-9		0.9	0.9	0.5						35
50-9		5.0	9.5	1.4	0.5					68
60-9		12.2	15.4	1.4	0.9	0.9				64
70-9		5.0	14.5	4.1	2.7	1.8	0.9		0.5	40
80-9		1.8	11.8	1.4	1.8	1.4				9
90-9		1.8	1.8					0.5		227

Table 34(d) : Horizon IV

Angle (degrees)	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
30-9		0.6								1
40-9	0.6	1.2								3
50-9	2.4	1.2	2.4	0.6						11
60-9	10.4	12.8	6.7	3.7	0.6		0.6			57
70-9	5.1	18.9	5.5	2.4	3.7		0.6	0.6		57
80-9	1.8	6.1	1.2	1.2	3.7		0.6			24
90-9	1.2	2.4	1.2	1.2	0.6					11
										164

Tables 35 : Shape of 'Whole' and 'Probably Whole'
Lengths of Use-Wear (Per cent)

Table 35(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Total No.
I	61.6	36.5	1.9	159
II	57.8	37.6	4.6	109
III	51.7	45.9	2.4	168
IV	51.4	46.7	1.9	154

Table 35(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Total No.
I	52.9	26.4	20.6	34
II	33.3	33.3	33.3	15
III	58.4	19.4	22.2	36
IV	41.1	23.1	35.9	39

Tables 36 : Length of 'Whole' and 'Probably Whole' Lengths of Use-Wear (Per cent)

Table 36(a) 'Chattering'

Horizon	Length in mm.							Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	>30	
I	55.4	39.0	3.1	2.5	-	-	-	159
II	53.2	34.9	10.1	1.8	-	-	-	109
III	53.6	32.2	12.5	1.2	0.6	-	-	168
IV	44.8	50.0	3.9	0.6	0.6	-	-	154

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Table 36(b) : 'Utilisation'

Horizon	Length in mm.						Total No.
	0-5	6-10	11-15	16-20	21-25	>30	
I	-	44.2	20.6	17.7	8.8	8.8	34
II	20.0	40.0	13.4	20.0	6.8	-	15
III	11.1	33.3	22.2	19.4	5.6	2.8	36
IV	5.1	17.9	35.8	17.9	12.8	5.1	39

Table 37 : Length of 'Whole' and 'Probably Whole' Edges (Per cent)

Table 37(a) : 'Chattering'

Horizon	Length in mm.						Total No.
	0-5	6-10	11-15	16-20	21-25	>30	
I	32.0	43.6	18.4	6.1	-	-	147
II	22.8	45.7	22.8	6.7	1.0	1.0	105
III	31.2	38.8	24.8	4.5	-	0.6	177
IV	20.1	63.3	13.9	2.8	0.7	-	144

Table 37(b) : 'Utilisation'

Horizon	Length in mm.						Total No.	
	0-5	6-10	11-15	16-20	21-25	26-30		>30
I	-	41.2	23.5	17.6	8.8	8.8	-	34
II	11.8	41.2	11.8	23.5	5.9	5.9	-	17
III	5.6	38.8	22.2	19.5	2.8	8.3	2.8	36
IV	5.0	17.5	35.0	20.0	12.5	5.0	5.0	40

Tables 38 : Shape of 'Whole' and 'Probably Whole' Edges (Per cent)

Table 38(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Wavy	Total
I	37.2	61.2	1.4	-	147
II	32.4	61.0	4.8	1.9	105
III	35.8	63.1	3.2	-	157
IV	31.2	66.0	2.8	-	144

Table 38(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	50.0	26.5	23.5	-	34
II	29.4	35.3	35.3	-	17
III	52.7	25.0	22.2	-	36
IV	45.0	20.0	35.0	-	40

Tables 39 : Preparatory Flaking (Per cent)

Table 39(a) : 'Chattering'

Horizon	Unclear	None	Base Struck	Side Struck	Not Applicable	Total No.
I	16.7	31.2	51.1	0.9	-	215
II	14.4	29.5	56.1	-	-	179
III	19.9	18.3	59.8	1.2	0.8	246
IV	20.1	22.3	55.4	0.9	1.3	224

Table 39(b) : 'Utilisation'

Horizon	Unclear	None	Base Struck	Side Struck	Not Applicable	Total No.
I	2.5	35.0	2.5	-	60.0	40
II	12.5	33.0	12.5	-	41.7	24
III	7.5	27.5	10.0	-	55.0	40
IV	4.2	8.3	4.2	-	83.3	48

Tables 40 : Number of Edges Made on
Core, Lumps, Flakes, etc. (Per cent)*

Table 40(a) : 'Chattering'

Horizon	Not Determinable	Core, Lump, Etc.	Flake	Trimming Flake	Total No.
I	4.3	43.8	48.2	3.7	187
II	0.8	35.7	56.4	7.1	126
III	3.3	29.7	62.8	4.2	212
IV	3.0	44.3	46.3	6.5	201

* Excluding implements 'Clearly Not Whole'.

Table 40(b) : 'Utilisation'

Horizon	Not Determinable	Core, Lump, Etc.	Flake	Trimming Flake	Total No.
I	-	17.9	76.9	5.1	39
II	-	31.8	59.1	9.1	22
III	2.6	7.7	84.5	5.1	39
IV	8.5	4.3	59.6	27.7	47

Tables 41 : Thickness of Implements,*
Using Edges as Basic Unit (Per cent)

Table 41 (a) : 'Chattering'

Horizon	Thickness in mm.					Total No.
	0-9	10-9	20-9	30-9	40-9	
I	8.0	63.1	23.6	5.3	-	187
II	9.5	50.8	30.2	7.1	2.4	126
III	7.5	64.2	17.9	5.7	-	212
IV	9.5	54.7	29.8	5.0	1.0	201

* 'Clearly Not Whole' implements excluded.

Table 41(b) : 'Utilisation'

Horizon	Thickness in mm.					Total No.
	0-9	10-9	20-9	30-9	40-9	
I	38.5	41.0	18.0	-	2.6	39
II	45.4	36.0	9.1	9.1	-	22
III	35.9	53.8	7.7	2.6	-	39
IV	42.6	48.7	8.5	-	-	47

Tables 42 : Weight of Implements,
Using Edges as the Basic Unit (Per cent)*

Table 42(a) : 'Chattering'

Horizon	Weight in gm.							Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9		70-9
I	39.1	39.1	12.3	4.8	4.3	0.5	-	-	187
II	23.8	33.3	15.9	15.9	5.6	-	1.6	4.0	126
III	26.9	53.3	4.2	7.1	3.8	2.8	1.9	-	212
IV	24.6	44.7	18.4	4.0	6.9	-	1.5	-	201

* 'Clearly Not Whole' implements excluded.

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Table 42(b) : 'Utilisation'

Horizon	Weight in gm.							Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	
I	58.9	25.6	7.7	5.1	2.6	-	-	39
II	68.2	9.1	9.1	4.5	-	-	-	22
III	58.9	30.8	2.6	5.1	-	2.6	-	39
IV	44.7	42.6	10.6	-	2.1	-	-	47

Tables 43 : Angle of 'Chattering' Use-Wear (Per cent)

Table 43(a) : No Retouch

Horizon	Not Meas.	Angle (Degrees)							Total No.	
		20-9	30-9	40-9	50-9	60-9	70-9	80-9		>89
I	1.0	-	1.0	3.9	16.5	25.2	25.2	12.6	14.6	103
II	-	-	4.3	2.9	14.5	23.2	29.0	20.3	7.2	69
III	3.4	-	2.2	4.5	15.7	29.2	28.1	7.9	12.4	89
IV	3.0	-	3.0	9.9	10.9	21.8	21.8	3.9	16.8	101

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Table 43(b) : Step-Flaking

Horizon	Not Meas.	Angle (degrees)							Total No.	
		20-9	30-9	40-9	50-9	60-9	70-9	80-9		>89
I	-	-	-	1.0	16.5	16.5	36.9	25.3	5.8	103
II	-	-	-	2.9	18.8	37.6	29.0	11.6	69	
III	1.3	-	-	9.2	25.7	37.9	24.3	6.6	152	
IV	1.7	-	-	0.8	9.2	26.7	34.2	17.5	10.0	120

Tables 44 : Shape of 'Whole' and 'Probably Whole' Lengths of Use-Wear (Per cent)

Table 44(a) : No Retouch

Horizon	Straight	Concave	Convex	Total No.
I	53.7	43.7	2.5	80
II	58.0	32.0	10.0	50
III	52.6	43.8	3.5	57
IV	53.9	41.3	4.8	63

Table 44(b) : Step-Flaking

Horizon	Straight	Concave	Convex	Total No.
I	72.2	26.4	1.4	72
II	58.6	39.7	1.7	58
III	51.4	46.7	1.9	107
IV	48.3	51.7	-	87

Tables 45 : Length of 'Whole' and 'Probably Whole'
Lengths of Use-Wear (Per cent)

Table 45(a) : No Retouch

Horizon	Lengths in mm.					Total No.
	0-5	6-10	11-15	16-20	21-25	
I	55.0	36.3	5.0	3.7	-	80
II	56.0	24.0	14.0	6.0	-	50
III	49.1	36.8	10.5	3.5	-	57
IV	38.1	50.8	7.9	1.6	1.6	63

Table 45(b) : Step-Flaking

Horizon	Lengths in mm.					Total No.
	0-5	6-10	11-15	16-20	21-25	
I	58.3	40.3	1.4	-	-	72
II	53.4	43.1	3.5	-	-	58
III	57.0	29.9	12.2	-	0.9	107
IV	48.3	50.6	1.1	-	-	89

Tables 46 : Preparatory Flaking (Per cent)

Table 46(a) : No Retouch

Horizon	Unclear	None	Base Struck		Side Struck		Not Applicable	Total No.
			37.8	1.0	-	-		
I	14.6	46.6	37.8	1.0	-	-	103	
II	15.9	39.1	44.9	-	-	-	69	
III	21.3	35.9	41.6	1.1	-	-	89	
IV	16.9	32.0	48.5	2.0	-	-	101	

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Table 46(b) : Step Flaking

Horizon	Unclear	None	Base Struck	Side Struck	Not Applicable	Total No.
I	19.4	17.5	62.1	1.0	-	103
II	15.9	24.6	59.4	-	-	69
III	19.1	9.9	69.7	1.3	-	152
IV	23.3	15.8	60.8	-	-	120

Tables 47 : Number of Edges Made on Flakes Etc.,
Excluding Broken Implements (Per Cent)

Table 47(a) : No Retouch

Horizon	Not Meas.	Core, Lump	Flake	Trimming Flake	Total No.
I	3.2	43.9	48.3	4.4	91
II	1.6	39.1	53.1	6.2	64
III	5.1	31.6	58.2	5.1	79
IV	5.4	40.2	44.6	9.8	92

Table 47(b) : Step-Flaking

Horizon	Not Meas.	Core, Lump	Flake	Trimming	Flake	Total No.
I	5.8	47.1	44.8	2.3		87
II	-	37.1	53.2	9.7		62
III	2.3	28.9	64.8	3.9		128
IV	0.9	47.2	49.1	2.8		106

Tables 48 : Thickness of Implements,
Using Edges as Basic Unit (Per cent)*

Tables 48(a) : No Retouch

Horizon	Thickness in mm.				Total No.
	0-9	10-9	20-9	30-9 40-9	
I	12.1	58.2	25.3	4.4	91
II	18.8	35.9	34.4	9.4	64
III	3.8	62.0	24.1	10.1	79
IV	15.2	62.0	15.2	7.6	92

* 'Clearly Not Whole' implements excluded.

Table 48(b) : Step-Flaking

Horizon	Thickness in mm.					Total No.
	0-9	10-9	20-9	30-9	40-9	
I	3.5	66.6	23.0	6.9	-	87
II	4.8	58.1	27.0	6.5	3.2	62
III	10.1	64.1	22.6	3.1	-	128
IV	4.7	48.1	42.5	2.8	1.9	100

Tables 49 : Weight of Implements,
Using Edges as Basic Unit (Per cent)*

Table 49(a) : No Retouch

Horizon	Weight in gm.										Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	
I	45.1	30.8	11.0	6.6	5.5	1.1	-	-	-	-	91
II	30.6	20.9	11.9	17.9	3.0	-	-	-	-	-	67
III	34.2	43.0	5.1	7.6	2.5	3.8	3.8	-	-	-	79
IV	33.7	41.3	12.0	3.3	8.7	-	1.1	-	-	-	92

*: Clearly Not Whole' implements excluded.

Table 49(b) : Step-Flaking

Horizon	Weight in gm.								Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	
I	32.2	48.3	12.6	3.5	3.5	-	-	-	87
II	12.9	43.6	19.4	12.9	8.1	1.6	1.6	-	62
III	22.6	58.6	3.9	7.0	4.7	2.3	0.8	-	128
IV	15.1	48.1	24.5	4.7	5.7	-	1.9	-	106

Table 50 : Angle of Use-Wear (Per cent)

	Angle (degrees)								Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	>89	
Chattering + Step Flaking (C+SF)			0.5	10.0	23.0	35.2	23.2	8.2	440
Chattering without Retouch (C-R)		2.5	5.6	14.4	25.0	25.8	13.3	13.3	360
Utilisation (U)	9.2	17.7	15.0	26.8	13.7	9.8	5.2	2.6	153

Bafari
Tables 49-50

Table 51 : Shape of 'Whole' and 'Probably Whole'
Lengths of Use-Wear (Per cent)

	Straight	Concave	Convex	Total No.
C+SF	56.5	42.3	1.2	326
C-R	54.4	40.8	4.8	250
U	48.0	24.0	28.0	125

Table 52 : Lengths of 'Whole' and 'Probably Whole'
Lengths of Use-Wear (Per cent)

	Length in mm.							Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	>30	
C+SF	54.2	40.2	5.2	-	0.3	-	-	326
-C-R	49.6	37.6	8.8	3.6	0.4	-	-	250
U	7.2	32.0	24.8	18.4	8.8	6.4	2.4	125

Table 53 : Preparatory Flaking

	Unclear	None	Base Struck	Side Struck	Not Applicable	Total No.
C+SF	19.8	15.5	64.0	6.8	-	444
C-R	19.6	36.2	43.1	1.1	-	362
U	6.0	24.7	6.7	-	64.0	150

Table 54 : Number of Edges Made on Flakes Etc.,
Excluding 'Clearly Not Whole' Implements (Per cent)

	Not Determinable	Core, Lump	Flake	Trimming Flake	Total No.
C+SF	2.4	39.4	53.0	4.2	383
C-R	4.0	38.9	50.6	6.4	326
U	3.4	12.9	70.7	12.9	147

Bahari
Tables 53-54

Table 55 : Shape of Edge,
Excluding 'Clearly Not Whole' Edges (Per cent)

	Straight	Concave	Convex	Total No.
C+SF	23.3	75.0	1.7	288
C-R	47.4	47.0	5.6	249
U	46.4	25.0	28.4	127

Table 56 : Length of 'Whole' and 'Probably Whole'
Edges (Per cent)

	Length in mm.							Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	>30	
C+SF	17.7	51.4	25.7	4.9	-	0.3	-	288
C-R	39.8	42.6	12.0	5.2	0.4	-	-	249
U	4.7	33.1	25.2	19.7	7.9	7.1	2.4	127

Table 57 : Base Types (Per cent)

	Not Deter- minable	Pebble Cortex	Other Cortex	Break	Negative Bulb	Positive Bulb	Not Applicable	Total No.
C+SF	7.0	2.0	6.5	7.0	28.2	49.4	-	444
C-R	9.1	4.4	9.4	5.5	35.4	36.2	-	362
U	3.3	0.7	-	2.0	12.0	16.7	62.7	150

Table 58 : Thickness of Implements,
Using Edges as Basic Unit (Per cent)*

	Thickness in mm.						Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	
C+SF	6.3	59.3	29.0	4.5	1.0	-	383
C-R	12.2	55.5	23.8	7.6	0.3	-	326
U	43.1	49.7	11.8	2.2	0.7	-	137

* 'Clearly Not Whole' implements excluded.

Table 59 : Weight of Implements,
Using Edges as Basic Unit (Per cent)*

	Weight in gm.								Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	
C-SF	21.2	50.9	14.1	6.5	5.2	1.0	1.0	-	388
C-R	37.4	35.0	10.1	8.3	5.2	1.2	1.5	1.2	326
U	59.9	32.1	8.0	4.4	2.2	0.7	-	-	137

* 'Clearly Not Whole' implements excluded.

Aibura : Flaked Implement Attributes

Table 1 : Type of Stone (Per cent)

Horizon	Chert	Non-Chert	Total No.
I	96.2	3.8	105
II	85.2	14.9	229
III	81.8	18.2	110

Table 2 : Number of Planes/Implement (Per cent)

Horizon	Number of Planes					Total No.
	1	2	3	4	5	
I	78.1	16.9	5.7	-	-	105
II	72.9	20.1	6.1	0.4	0.4	229
III	71.8	23.6	3.6	0.9	-	110

Table 3 : Number of Edges/Implement (Per cent)

Horizon	Number of Edges									Total No.
	1	2	3	4	5	6	7	8	9	
I	41.9	26.7	17.1	8.6	4.6	-	1.0	-	-	105
II	26.2	24.5	17.5	13.1	5.7	8.3	3.9	-	0.9	229
III	34.5	20.9	15.5	8.2	7.3	9.1	1.8	0.9	1.8	110

Table 3. i. Weight of all Implements (Per cent)

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	68.6	37.1	4.8	1.9	1.0	-	5.8	1.0	-	-	-	-	-	105
II	34.6	28.4	13.5	11.4	4.8	1.8	2.6	1.8	1.3	0.4	1.3	-	-	409
III	31.6	25.7	16.4	15.7	9.1	9.1	5.5	1.8	2.7	1.8	-	0.9	2.7	110

Table 5. i. Weights of Implements in Relation to Plains (Per cent)

Table 5(a). i. Weight of Implements Used on One Plains

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	72.0	14.6	4.9	2.4	1.2	1.2	3.7	-	-	-	-	-	-	82
II	38.5	24.6	10.8	15.2	4.8	1.8	2.4	1.8	1.2	-	1.2	-	-	167
III	13.9	26.6	13.9	13.9	5.1	11.4	7.6	1.3	2.5	2.5	-	1.3	-	79

Table 5(b). i. Weight of Implements Used on Two Plains

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	28.8	23.5	5.9	-	5.9	-	-	5.9	-	-	-	-	-	17
II	17.4	27.0	21.7	6.5	4.4	2.2	4.4	2.2	-	2.2	2.2	-	-	46
III	15.4	15.4	26.9	3.9	23.1	3.9	-	3.9	3.9	-	-	-	3.9	26

Table 6. i. Weights of Implements in Relation to Edges (Per cent)

Table 6(a). i. Weight of Implements with 1 or 2 Edges

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	72.3	13.9	2.8	2.8	1.4	1.4	-	5.6	-	-	-	-	-	72
II	82.2	68.7	9.5	10.5	2.6	1.7	3.4	0.9	0.9	0.9	0.9	-	-	116
III	16.4	19.7	16.4	13.1	6.6	11.5	8.2	1.6	3.3	1.6	1.6	-	-	61

Table 6(b). i. Weight of Implements with More than 2 Edges

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	60.8	24.2	9.1	-	3.2	-	-	-	3.2	-	-	-	-	33
II	53.0	50.1	17.7	10.6	7.1	1.7	1.7	2.7	1.7	-	1.7	-	-	113
III	12.2	26.5	16.5	12.2	12.2	6.1	2.0	2.0	1.0	1.0	-	-	6.1	49

Table 7 : Whole/not whole Implements, Assessed in Relation to a Particular Edge (Per cent)

Horizon	Whole	Probably Whole	Not Whole	Indeterminate	Total No.
I	16.7	18.5	2.7	62.2	222
II	8.8	6.9	6.6	77.8	672
III	5.5	15.1	4.8	74.6	311

Table 8 : Raw Material of Implements (Per cent)

Table 8(a) : Treating each Edge as a Separate
Implement

Horizon	Pebble cortex	Other cortex	No cortex	Indeterminate	Total No.
I	14.9	13.1	66.2	5.9	222
II	31.7	30.8	31.2	6.2	672
III	34.7	24.1	37.9	3.2	311

Table 8(b) : Each Implement Scoring Once Only

Horizon	Pebble cortex	Other cortex	No cortex	Indeterminate	Total No.
I	14.3	13.3	62.8	9.5	105
II	31.9	30.6	30.1	7.4	229
III	40.0	24.5	30.0	5.5	110

Table 2(a) : Weight of 'Whole' Implements with 'Whole' Assessed in Relation to Each Edge. (Per cent)

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	86.5	10.8	-	-	-	-	-	2.7	-	-	-	-	-	27
II	39.0	37.3	8.5	8.5	5.1	-	1.7	-	-	-	-	-	-	59
III	35.3	5.9	11.8	35.3	5.9	-	-	-	-	5.9	-	-	-	17

Table 2(b) : Weight of 'Probably Whole' Implements with 'Probably Whole' Assessed in Relation to Each Edge. (Per cent)

Horizon	Weight in gm.													Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	>119	
I	85.4	9.8	-	-	-	-	-	2.4	2.4	-	-	-	-	11
II	34.8	30.4	8.7	-	8.7	4.4	2.2	6.5	-	-	4.4	-	-	46
III	12.8	19.2	14.9	8.5	6.4	17.0	-	4.3	4.3	6.5	-	4.3	-	17

Albura
Table 2

Table 10(a) : Shape of 'Whole' Implements as Expressed by Length/Breadth Index (Per cent)

Horizon	L/B Index					Total No.
	1 - 1.49	1.5 - 1.99	2 - 2.49	2.5 - 2.99	>2.99	
I	32.4	51.4	16.2	-	-	37
II	72.9	20.3	3.4	3.4	-	59
III	76.5	17.7	-	5.9	-	17

Table 10(b) : Shape of 'Whole' Implements as Expressed by Breadth/Thickness Index (Per cent)

Horizon	B/Th Index							Total No.
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99	
I	-	5.4	13.5	37.8	16.2	10.8	16.2	37
II	-	6.8	5.1	30.5	27.1	3.4	27.1	59
III	-	11.8	11.8	11.8	29.4	-	35.3	17

Ahpara
 Tables 10

Table 11(a) : Shape of 'Probably Whole' Implements as Expressed by Length/Breadth Index (Per cent)

Horizon	Not meas.	L/B Index						Total No.
		1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99		
I	2.4	70.7	14.6	9.8	-	2.4	41	
II	-	73.9	26.1	-	-	-	46	
III	-	89.4	8.5	2.1	-	-	47	

Table 11(b) : Shape of 'Probably Whole' Implements as Expressed by Breadth/Thickness Index (Per cent)

Horizon	Not meas.	B/Th Index								Total No.
		<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99		
I	-	-	2.4	14.6	22.0	22.0	17.1	22.0	41	
II	-	-	2.2	4.4	26.1	23.9	34.8	8.7	46	
III	-	2.2	2.2	14.9	31.9	17.0	14.9	17.0	47	

Table 12 : Core and Flake Components of the Industry (Per cent)

Horizon	Core or lump	Flake	Trimming flake	Indeterminate	Total No.
I	25.2	65.4	3.6	5.9	222
II	34.5	43.4	2.7	6.2	672
III	53.4	36.9	2.2	3.2	311

Table 13 : Condition of Edges (Per cent)

Horizon	Whole	Probably whole	Not whole	Indeterminate	Total No.
I	42.3	27.5	3.6	26.6	222
II	22.5	30.5	15.2	31.8	672
III	27.7	30.2	6.8	35.4	311

Aibura
Tables 12-13

Table 14 : Base Types (Per cent)

Horizon	Indeter- minate	Pebble cortex	Other cortex	Break	Negative bulb	Positive bulb	Not applicable	Total No.
I	5.9	0.9	1.4	5.9	34.7	27.0	24.3	222
II	9.2	7.1	8.6	7.6	26.0	35.6	5.8	672
III	4.5	9.7	8.0	7.7	36.3	31.2	2.6	311

Table 15 : Preparatory Flaking (Per cent)

Horizon	Unclear	None	Base struck	Side or End struck	Not applicable	Total No.
I	12.6	40.5	22.1	0.5	24.3	222
II	17.3	22.5	54.0	0.5	5.8	672
III.....	19.3	24.4	53.4	0.3	2.6	311

Aibura
Tables 14-15

Table 16 : Shapes of Edges (Per cent)

Table 16(a) : Shape of 'Whole' Edges

Horizon	Straight	Concave	Convex	Wavy	Total
I	41.5	39.4	19.2	-	94
II	28.5	66.9	4.6	-	151
III	23.3	73.3	3.5	-	86

Table 16(b) : Shape of 'Probably Whole' Edges

Horizon	Straight	Concave	Convex	Wavy	Total
I	47.5	47.5	4.9	-	61
II	30.2	66.8	2.9	-	205
III	29.8	66.0	4.3	-	94

Tables 17 : Lengths of Edges (Per cent)

Table 17(a) : Lengths of Straight 'Whole' and 'Probably Whole' Edges

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	19.1	51.5	19.1	7.4	1.5	1.5	-	-	68
II	25.7	44.7	19.1	7.6	2.9	-	-	-	105
III	33.3	50.0	10.4	4.2	2.1	-	-	-	48

Table 17(b) : Lengths of Concave 'Whole' and 'Probably Whole' Edges

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	13.6	53.0	28.8	4.5	-	-	-	-	66
II	10.5	52.0	23.4	8.9	0.4	0.4	-	-	248
III	5.6	50.4	32.8	8.0	3.2	-	-	-	125

Table 17(c) : Lengths of Convex 'Whole' and 'Probably Whole' Edges

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	4.8	38.1	38.1	19.1	-	-	-	-	21
II	-	46.2	30.8	7.7	-	7.7	7.7	-	13
III	-	57.1	28.6	-	14.3	-	-	-	7

Alburra
Tables 17

Table 18 : Indentation Index of 'Whole' and 'Probably Whole' Concave Edges (Per cent)

Horizon	Lc/D				Total
	<3.3	3.3-4.9	5.0-9.9	10.0-19.9	
I	1.5	10.6	69.6	18.2	66
II	0.4	12.5	60.5	22.6	248
III	0.8	16.0	65.6	17.6	125

Table 19 : Projection Index of 'Whole' and 'Probably Whole' Convex Edges (Per cent)

Horizon	Lc/D				Total
	<3.3	3.3-4.9	5.0-9.9	10.0-19.9	
I	-	14.3	38.1	42.9	21
II	-	14.3	46.2	46.2	13
III	-	14.3	57.2	28.6	7

Table 20 : Retouch Type on Edges (Per cent)

Horizon	None	Step flaking		Other unifacial flaking	Bifacial flaking	Other	Total
		Light	Heavy				
I	71.2	24.8	1.4	1.8	-	0.9	222
II	25.7	62.5	9.7	1.9	0.2	-	672
III	20.3	64.6	12.5	2.3	0.3	-	311

Tables 21 : Angle of Edge on Retouched Edges (Per cent)

Table 21(a) : Light Step Flaking

Horizon	Not meas.	Angle (degrees)								Total No.		
		20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		100-9	>109
I	-	-	-	3.6	5.5	29.1	27.3	18.2	10.9	3.6	1.8	55
II	0.2	-	-	2.1	8.6	29.5	28.1	21.4	8.8	1.2	-	420
III	1.0	-	-	0.5	2.5	22.4	31.3	26.9	12.4	3.0	-	201

Table 21(b) : Heavy Step Flaking

Horizon	Not meas.	Angle (degrees)								Total No.		
		20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		100-9	>109
I	-	-	-	-	33.3	-	66.6	-	-	-	-	3
II	3.1	-	-	-	4.6	18.5	36.9	29.2	6.2	1.5	-	65
III	5.1	-	-	-	5.1	18.0	43.6	23.1	5.1	-	-	39

Aibur
Tables 21

Table 22 : Types of Use-Wear (Per cent)

Horizon	None	Chattering	Bifacial	Utilisation	Total No.
I	16.2	52.7	0.5	30.6	222
II	45.8	47.5	-	6.7	672
III	44.7	51.8	-	3.5	311

Tables 23 : Shape of 'Whole' and 'Probably Whole'
Lengths of Use-wear (Per cent)

Table 23(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	51.9	46.8	1.3	-	79
II	42.7	55.5	1.7	-	173
III	47.9	50.0	2.1	-	96

Table 23(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	43.1	27.6	29.3	-	58
II	45.4	53.4	21.2	-	33
III	50.0	12.5	37.5	-	8

Aibura
Table 23

Tables 24 : Lengths of 'Whole' and 'Probably Whole'
Lengths of Use-wear (Per cent)

Table 24(a) : 'Chattering'

Horizon	Length in mm.							Total No.	
	1-5	6-10	11-15	16-20	21-25	26-30	31-35		>35
I	24.0	53.1	20.2	1.3	-	-	-	-	79
II	36.4	47.2	12.5	2.8	1.1	-	-	-	176
III	31.4	50.0	14.7	3.9	-	-	-	-	102

Table 24(b) : 'Utilisation'

Horizon	Length in mm.							Total No.	
	1-5	6-10	11-15	16-20	21-25	26-30	31-35		>35
I	6.9	43.1	31.0	15.5	1.7	1.7	-	-	58
II	3.0	33.3	24.2	24.2	6.1	6.1	3.0	-	33
III	-	62.5	-	12.5	24.0	-	-	-	8

Tables 25 : Indentation Index for 'Whole' and
'Probably Whole' Concave Lengths of Use-wear
(Per cent)

Table 25(a) : 'Chattering'

Horizon	Lc/d					Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9	
I	-	8.1	81.1	8.1	2.7	37
II	3.1	13.6	66.7	15.6	1.0	36
III	-	14.6	68.8	16.7	-	48

Table 25(b) : 'Utilisation'

Horizon	Lc/d					Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9	
I	6.3	-	56.2	27.5	-	16
II	-	-	45.5	54.5	-	11
III	-	-	-	100.0	-	1

Tables 26 : Relationship of Retouch Type and Edge Shape
on 'Whole' and 'Probably Whole' Edges
(Per cent)

Table 26(a) : Edges Without Retouch

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	50.8	32.5	16.7	-	120
II	49.0	42.0	9.0	-	100
III	53.8	35.9	10.3	-	39

Table 26(b) : Edges with Light Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	21.8	75.0	3.1	-	32
II	22.6	76.1	1.4	-	213
III	21.7	76.6	1.7	-	115

Table 26(c) : Edges with Heavy Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	-	100.0	-	-	1
II	15.2	81.8	3.0	-	33
III	4.8	95.2	-	-	21

Alburn
Tables 26

Tables 27 : General Angle of Edges with Use-wear (Per cent)

Table 27(a) : 'Chattering'

Horizon	Angle (degrees)										Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	90-9	90-9		
I	0.9	2.6	7.7	15.4	24.8	24.8	14.5	7.7			1.7	117
II	0.6	1.3	1.3	9.1	20.7	25.1	24.5	16.0			1.6	319
III	-	-	0.6	5.0	14.9	29.2	30.4	16.2			3.7	161

Table 27(b) : 'Utilisation'

Horizon	Angle (degrees)										Not Meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	90-9	90-9		
I	17.6	13.2	20.6	26.5	11.8	5.9	4.4	-			-	68
II	6.7	11.1	28.9	24.4	15.6	4.4	2.2	4.4			2.2	45
III	9.1	-	36.4	-	27.3	-	9.1	18.2			-	11

Tables 28 : Use-wear Types in Relation to Retouch (Per cent)

Table 28(a) : 'Chattering'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	76.9	23.1	-	117
II	43.2	47.8	9.0	324
III	35.0	54.4	10.6	160

Table 28(b) : 'Utilisation'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	100.0	-	-	67
II	100.0	-	-	43
III	100.0	-	-	10

Aibura
 Tables 28

Tables 29 : Retouch Types in Relation to Use-wear (Per cent)

Table 29(a) : Light Step Flaking

Horizon	Use-wear			Total No.
	Chattering	Bifacial	Utilisation	
I	100.0	-	-	27
II	100.0	-	-	155
III	100.0	-	-	87

Table 29(b) : Heavy Step Flaking

Horizon	Use-wear			Total No.
	Chattering	Bifacial	Utilisation	
I	-	-	-	0
II	100.0	-	-	29
III	100.0	-	-	17

Table 29(c) i No. Retouch

Horizon	Chattering	Use-wear		Total No.
		Bifacial	Utilisation	
I	57.0	0.6	42.4	158
II	76.5	-	23.5	183
III	84.8	-	15.2	66

Aibura
Table 29

**Tables 30 : Implement Thickness in Relation to Retouch Type
on all Implements not 'Clearly not Whole'
(Per cent)**

Table 30(a) : Light Step Flaking

Horizon	Not meas.	Thickness in mm.								Total No.
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	-	13.0	33.3	1.9	27.8	9.3	7.4	5.6	1.9	54
II	0.3	1.5	19.9	22.7	27.8	15.4	7.8	3.0	1.1	396
III	-	-	11.9	19.2	21.8	20.7	10.4	8.3	7.9	193

Table 30(b) : Heavy Step Flaking

Horizon	Not meas.	Thickness in mm.								Total No.
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	-	-	-	-	33.3	66.6	-	-	-	3
II	-	1.7	13.6	25.4	28.8	23.7	6.8	-	-	59
III	-	-	8.6	40.0	8.6	34.3	8.6	-	-	35

Table 30(c) : No Retouch

Horizon	Not meas.	Thickness in mm.								Total No.
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	6.5	38.3	33.0	9.1	2.6	6.5	1.9	0.6	1.3	154
II	4.3	6.8	27.0	20.2	19.6	12.3	5.5	1.8	2.4	163
III	-	11.7	11.7	23.4	20.0	23.4	-	1.7	8.4	60

Aidura
Tables 30

Tables 31 : Breadth/Thickness Index in Relation to Retouch
Type on Implements not 'Clearly not Whole'
(Per cent)

Table 31(a) : Light Step Flaking

Horizon	B/Th Index							Total No.
	<0.5	0.5-0.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99	
I	-	9.3	37.0	24.1	16.7	11.1	1.9	54
II	0.5	9.8	41.9	29.5	8.8	6.6	2.8	396
III	-	14.5	40.4	23.8	13.5	5.2	2.6	193

Table 31(b) : No Retouch

Horizon	B/Th index							Total No.
	<0.5	0.5-0.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99	
I	0.6	8.4	16.2	31.8	16.9	13.6	12.3	154
II	-	15.9	23.9	24.6	11.0	11.0	13.5	163
III	1.7	8.3	31.7	30.0	6.7	5.0	15.0	60

Aibura
Tables 31

Kafiavana : Flaked Implement Attributes

Table 1 : Types of Stone Used (Per cent)

Horizon	Red-brown greasy chert	Other greasy chert	Non-greasy chert and other materials	Total No.
I	51.2	37.2	11.6	164
II	54.9	28.8	16.4	226
III	50.1	34.2	15.7	351
IV	52.8	34.9	12.3	284
V	49.9	36.6	13.5	325
VI	54.7	29.2	16.2	192
VII	50.9	37.6	11.5	165
VIII	44.6	26.2	29.2	202
IX	35.6	17.8	46.7	45

Table 2(a) : Number of Planes/Implement (Per cent)

Horizon	Number of Planes				Total No.
	1	2	3	4	
I	76.8	20.1	3.1	-	164
II	77.9	17.7	4.4	-	226
III	83.2	13.7	2.3	0.9	251
IV	80.3	18.0	1.4	0.4	284
V	80.3	17.9	1.9	-	325
VI	86.5	13.0	0.5	-	192
VII	84.2	14.6	1.2	-	165
VIII	81.2	16.4	2.5	-	202
IX	82.2	17.8	-	-	45

Table 2(b) : Number of Edges/Implement (Per cent)

Horizon	Number of Edges									Total No.	Mean Number per Horizon
	1	2	3	4	5	6	7	8	9		
I	33.5	38.4	15.2	6.1	6.1	-	0.6	-	-	164	2.15
II	41.2	29.7	15.9	6.6	3.5	2.7	0.4	-	-	226	2.09
III	43.3	30.8	13.7	6.8	2.6	1.4	1.4	-	-	351	2.05
IV	43.7	29.9	14.8	6.7	2.5	1.1	0.7	-	-	284	2.04
V	36.9	34.2	15.1	6.8	3.1	1.2	0.9	0.6	0.3	325	2.21
VI	45.8	26.6	17.2	5.2	2.6	2.1	0.5	-	-	192	2.00
VII	38.2	26.1	13.9	11.5	4.9	3.6	1.2	0.6	-	165	2.38
VIII	37.1	22.8	21.8	7.4	6.9	2.5	0.5	-	1.0	202	2.39
IX	53.3	35.6	4.4	4.4	2.2	-	-	-	-	45	1.67

Table 3.1. Weight of All Implements (Per cent)

Horizon	Weight in gm.														Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	129	
I	45.7	23.8	16.5	6.1	4.3	1.8	-	0.6	0.6	-	-	-	-	0.6	164
II	27.8	28.5	16.4	10.6	4.9	2.2	3.1	1.3	0.9	0.9	0.4	-	-	3.1	226
III	27.6	28.2	21.1	7.7	5.1	2.6	1.1	1.4	1.1	0.6	0.2	0.6	-	2.0	251
IV	23.5	31.9	18.6	10.2	5.3	3.2	2.1	1.4	0.7	0.4	1.1	-	0.4	1.4	285
V	22.5	28.1	18.5	11.1	7.1	3.1	1.2	1.5	0.3	2.2	0.6	0.9	0.6	2.2	344
VI	21.9	20.2	17.2	13.5	8.3	3.1	2.1	1.0	-	-	1.0	0.5	-	1.0	192
VII	17.0	27.2	18.2	12.1	8.5	5.5	3.0	2.4	3.0	1.8	-	-	-	1.2	165
VIII	25.2	17.3	12.9	12.4	4.0	3.0	4.5	2.5	1.5	1.5	2.5	2.0	2.0	9.4	202
IX	20.0	13.3	11.1	17.8	4.4	8.9	-	6.7	-	2.2	2.2	2.2	2.2	11.1	45

Table 3.2. Weight of Implements in Relation to Plans (Per cent)

Table 3(a). Weight of Implements Used on One Plane

Horizon	Weight in gm.														Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	129	
I	49.6	22.4	15.2	5.6	3.2	2.4	-	0.8	0.8	-	-	-	-	1.7	125
II	25.0	25.7	15.3	10.2	4.5	2.8	3.4	1.1	1.1	0.6	0.6	-	-	1.7	178
III	20.5	28.4	18.9	7.5	5.1	3.1	4.4	1.0	1.0	0.7	0.3	0.7	-	1.4	202
IV	26.2	20.6	17.5	8.7	6.1	2.6	2.2	1.8	0.9	0.4	1.3	-	-	1.4	239
V	24.6	29.6	18.1	9.6	5.4	3.1	0.8	1.9	-	2.7	0.8	0.8	0.8	1.9	260
VI	25.3	31.3	17.5	11.4	6.6	1.8	1.8	1.2	-	1.2	0.6	-	-	3.2	166
VII	18.0	26.6	17.3	13.0	8.6	5.8	3.6	2.2	1.4	2.2	-	-	-	1.4	139
VIII	29.3	16.5	13.4	13.4	3.7	3.7	2.4	1.8	1.2	-	1.2	3.1	1.8	7.9	164
IX	24.3	16.2	13.5	16.2	2.7	5.4	-	8.1	-	-	-	-	13.5	8.1	37

Kafarawa
Table 3-a

Table 4(b). Weight of Implants used on Two Plains

Horizon	Weight in gm.												Total No.		
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9		120-9	>129
I	30.3	30.3	21.2	6.1	9.1	-	-	-	-	-	-	-	-	-	33
II	10.0	37.5	20.0	15.0	7.5	-	-	2.5	2.5	-	-	-	-	-	40
III	14.6	29.2	33.3	8.3	8.3	-	4.2	-	-	-	-	-	-	-	46
IV	12.7	21.4	25.5	13.7	5.8	3.9	5.0	-	-	-	-	-	2.0	2.1	51
V	12.0	21.4	22.0	12.0	11.0	3.4	-	-	1.7	-	-	-	-	3.4	58
VI	8.3	24.2	25.0	24.0	12.0	4.0	-	-	-	-	-	-	-	-	25
VII	8.3	24.2	25.0	8.3	8.3	8.2	-	4.2	12.5	-	-	-	-	-	24
VIII	3.0	24.2	9.1	9.1	3.0	-	15.1	6.1	3.0	9.1	-	-	-	3.0	33
IX	-	-	-	25.0	12.5	25.0	-	-	-	-	12.5	25.0	-	-	8

Table 5. Weight of Implants in Relation to Edges (Per cent)

Table 5(a). Weight of Implants with 1 or 2 Edges

Horizon	Weight in gm.												Total No.		
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9		120-9	>129
I	51.7	20.3	14.4	4.1	5.1	1.7	-	0.8	0.8	-	-	-	-	0.8	118
II	35.0	26.9	15.0	10.0	3.7	2.9	1.9	1.9	0.6	0.6	0.6	-	-	1.3	169
III	31.5	28.1	16.2	7.3	5.4	3.1	1.5	0.8	1.2	0.8	0.4	0.4	-	1.5	260
IV	28.6	30.5	17.6	7.1	6.7	2.4	1.9	1.0	1.0	0.5	1.4	-	-	1.4	210
V	29.1	26.5	17.0	8.7	7.4	2.6	0.4	1.7	0.4	2.2	0.4	0.9	0.4	2.2	230
VI	25.9	26.0	15.1	7.9	8.6	1.4	2.2	1.4	-	-	0.7	-	-	0.7	139
VII	20.8	20.2	17.0	11.3	7.6	6.6	2.8	0.9	0.9	-	-	-	-	0.9	106
VIII	34.7	15.7	10.7	10.7	4.1	3.3	3.3	1.7	-	1.7	2.5	0.8	7.4	121	
IX	22.5	15.0	12.5	15.0	5.0	7.5	-	5.0	-	-	2.5	2.5	-	12.5	40

Table 5(b). Weight of Implants with more than 2 Edges (Per cent)

Horizon	Weight in gm.												Total No.		
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9		120-9	>129
I	30.4	32.6	21.8	10.9	2.2	2.2	-	-	-	-	-	-	-	-	46
II	10.6	31.8	19.7	12.1	7.6	1.5	6.1	-	1.5	1.5	-	-	-	-	7.6
III	11.0	28.6	35.2	8.8	4.4	1.1	-	3.3	1.1	-	-	1.1	-	-	3.3
IV	9.3	36.0	21.3	18.7	1.3	5.3	2.7	2.7	-	-	-	-	1.3	1.3	75
V	6.4	31.9	22.4	17.0	6.4	4.3	3.2	1.1	-	2.1	1.1	1.1	1.1	2.1	94
VI	11.3	15.1	22.6	28.3	7.5	7.5	1.9	-	-	1.9	1.9	-	-	1.9	53
VII	10.2	22.0	20.4	13.6	10.2	3.4	3.4	5.1	6.8	3.4	-	-	-	1.7	59
VIII	11.1	19.8	16.1	14.8	3.7	2.5	6.2	1.2	1.2	3.7	1.2	2.5	3.7	12.3	81
IX	-	-	-	40.0	-	20.0	-	20.0	-	-	-	20.0	-	-	5

Table 6. Whole/Not Whole Implants, Assessed in Relation to a Particular Edge (Per cent)

Horizon	Whole			Probably Whole			Not Whole			Indeterminate			Total No.
	I	II	III	IV	V	VI	IV	V	VI	IV	V	VI	
I	5.1	-	-	23.5	-	-	9.4	-	-	62.0	-	-	353
II	4.8	-	-	19.5	-	-	7.5	-	-	68.2	-	-	478
III	5.2	-	-	17.9	-	-	8.8	-	-	68.2	-	-	717
IV	1.2	-	-	21.7	-	-	8.3	-	-	69.8	-	-	789
V	2.0	-	-	17.9	-	-	8.1	-	-	67.8	-	-	789
VI	6.0	-	-	14.6	-	-	12.3	-	-	71.1	-	-	381
VII	1.1	-	-	18.1	-	-	7.3	-	-	72.8	-	-	482
VIII	1.9	-	-	18.1	-	-	7.3	-	-	72.8	-	-	482
IX	17.3	-	-	6.0	-	-	2.7	-	-	72.0	-	-	75

Kafkavans
Table 5-6

Table 7(a) : Raw Material, Treating each Edge
as a Separate Implement (Per cent)

Horizon	Pebble Cortex	Other Cortex	No Cortex	Indeterminate	Total No.
I	49.0	12.5	34.0	4.5	353
II	55.2	18.8	21.4	4.6	478
III	52.4	15.9	27.8	3.9	717
IV	57.4	14.8	25.2	2.6	580
V	48.1	20.6	26.7	4.6	719
VI	59.6	12.7	24.1	3.6	386
VII	52.9	11.3	31.0	4.9	391
VIII	60.6	6.8	26.5	6.0	482
IX	58.6	16.0	20.0	5.3	75

Table 7(b) : Raw Material, each Implement
Scoring Once Only (Per cent)

Horizon	Pebble Cortex	Other Cortex	No Cortex	Indeterminate	Total No.
I	48.2	12.2	33.6	6.1	164
II	54.0	17.7	21.2	7.1	226
III	53.0	14.2	28.2	4.6	351
IV	55.1	15.8	24.9	4.2	285
V	49.7	20.1	24.7	5.6	324
VI	60.4	12.0	22.4	5.2	192
VII	55.1	9.7	29.7	5.5	165
VIII	57.4	8.4	26.8	7.4	202
IX	53.3	17.8	24.4	4.4	45

Table 8(c). Weight of 'Probably Whole' Implements, with 'Wholes' Assessed in Relation to Each Edge (Per cent)

Horizon	Weight in gm.													Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9		>129
I	50.0	38.8	11.2	-	-	-	-	-	-	-	-	-	-	-	18
II	39.1	13.1	17.4	13.1	4.3	-	4.3	-	-	-	-	-	-	8.7	23
III	54.1	8.1	21.6	2.7	-	2.7	-	-	2.7	-	-	-	-	6.1	37
IV	50.0	50.0	-	-	-	-	-	-	-	-	-	-	-	-	8
V	46.1	46.1	-	-	-	7.7	-	-	-	-	-	-	-	-	13
VI	39.1	38.8	-	17.4	-	-	8.7	-	-	-	-	-	-	-	23
VII	37.5	50.0	-	-	12.5	-	-	-	-	-	-	-	-	-	8
VIII	22.2	44.4	33.3	-	-	-	-	-	-	-	-	-	-	-	9
IX	23.1	7.7	7.7	61.5	-	-	-	-	-	-	-	-	-	-	15

Table 8(d). Weight of 'Probably Whole' Implements, with 'Probably Wholes' Assessed in Relation to Each Edge (Per cent)

Horizon	Weight in gm.													Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9		>129
I	49.4	30.1	13.2	2.4	2.4	-	-	2.4	1.3	-	-	-	-	-	63
II	51.8	31.2	18.3	12.9	2.2	3.2	4.3	-	2.2	-	-	-	-	-	92
III	14.1	36.8	21.1	12.5	3.1	2.3	1.6	6.2	0.8	-	-	-	-	1.6	168
IV	36.7	35.7	7.9	13.5	3.2	7.1	3.2	4.8	-	1.6	-	-	3.2	3.2	166
V	28.7	28.8	17.8	4.7	8.5	-	0.8	0.8	-	3.1	1.6	3.9	-	5.4	129
VI	22.1	23.6	13.2	10.3	8.8	1.5	-	-	-	2.9	4.4	-	-	4.4	68
VII	22.8	17.6	22.8	14.0	5.3	8.8	1.8	1.8	3.5	1.8	-	-	-	-	57
VIII	21.8	3.5	14.9	21.8	4.6	3.5	-	2.3	-	1.1	-	-	11.5	14.9	87
IX	-	-	16.7	-	33.3	33.3	-	-	-	-	-	-	-	16.7	6

Table 2(c). Weight of Net Wholly Investments with Net Knobs.
 Expressed as Percent of Total Net Wholly Investments

Horizon	Weight in %													Total No.	
	0-y	10-y	20-y	30-y	40-y	50-y	60-y	70-y	80-y	90-y	100-y	110-y	120-y		>120
I	39.4	26.4	15.2	9.1	-	-	-	-	-	-	-	-	-	-	33
II	38.9	16.7	30.5	8.3	2.8	-	2.8	-	-	-	-	-	-	-	36
III	39.7	27.0	22.2	9.5	1.6	-	-	-	-	-	-	-	-	-	63
IV	41.6	25.0	12.5	8.3	4.2	2.1	-	6.3	-	-	-	-	-	-	48
V	27.6	41.4	15.5	8.6	6.9	-	-	-	-	-	-	-	-	-	58
VI	37.2	17.1	20.0	22.8	2.9	-	-	-	-	-	-	-	-	-	35
VII	20.8	39.6	16.7	2.1	10.4	2.1	-	6.3	-	-	-	-	-	-	48
VIII	34.2	20.0	5.7	2.9	8.6	-	-	-	-	-	2.9	-	-	-	35
IX	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	2

Table 2(d). Share of Net Wholly Investments as Expressed by
 Land/Brackish Index (per cent)

Horizon	1/3 Index						1/2 Index						Total
	1-1.49	1.5-1.99	2-2.49	2.5-2.99	3-2.99	>3.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	3-2.99	>3.99	
I	61.1	33.3	5.6	-	-	-	5.6	4.4	-	-	-	18	
II	56.5	39.1	4.4	-	-	-	4.4	2.7	-	-	-	23	
III	78.4	18.9	-	-	-	-	-	-	-	-	-	37	
IV	71.4	28.6	-	-	-	-	-	-	-	-	-	7	
V	65.2	34.8	-	-	-	-	-	-	-	-	-	14	
VI	50.0	25.0	25.0	-	-	-	25.0	-	-	-	-	23	
VII	66.7	33.3	-	-	-	-	-	-	-	-	-	8	
VIII	66.7	33.3	-	-	-	-	-	-	-	-	-	9	
IX	15.4	76.9	-	-	-	-	-	-	7.7	-	-	13	

Table 9(b) : Shape of 'Whole' Implements as
Expressed by Breadth/Thickness Index (Per cent)

Horizon	B/Th. Index								Total No.
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99		
I	-	-	5.6	-	33.3	16.7	44.4	18	
II	-	-	17.4	13.0	39.1	21.7	8.7	23	
III	-	-	-	13.5	25.7	5.4	51.4	37	
IV	-	-	-	14.3	28.6	14.3	42.9	7	
V	-	-	7.1	-	50.0	21.4	21.4	14	
VI	-	-	4.4	26.1	8.7	26.1	34.8	23	
VII	-	-	12.5	-	25.0	25.0	37.5	8	
VIII	-	-	-	-	33.3	22.2	44.4	9	
IX	-	7.7	-	30.8	-	46.2	15.4	13	

Table 10(a) : Shape of 'Probably Whole' Implements
as Expressed by Length/Breadth Index (Per cent)

Horizon	L/B Index					Total No.
	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99	
I	78.3	13.3	3.6	-	4.8	83
II	55.9	33.3	9.7	-	1.1	93
III	83.6	12.2	3.9	-	-	128
IV	69.0	28.6	1.6	0.8	-	126
V	65.9	21.7	10.1	0.8	1.6	129
VI	80.9	13.2	2.9	2.9	-	68
VIII	73.7	14.0	3.5	8.8	-	57
VIII	74.7	18.4	4.6	-	2.3	87
IX	100.0	-	-	-	-	6

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Table 10(b)

Table 10(b) : Share of 'Probably Whole' Implements
as Expressed by Breadth/Thickness Index (Per cent)

Horizon	B/Th. Index									Total No.
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	>2.99			
I	-	3.6	26.5	18.1	14.5	12.1	25.3			83
II	-	6.5	21.5	23.7	20.4	12.9	15.1			93
III	-	2.3	16.4	21.9	20.3	25.8	13.3			128
IV	-	4.0	23.0	19.1	21.4	19.8	12.7			126
V	1.6	3.9	24.8	29.5	18.6	7.8	14.0			129
VI	-	7.4	19.1	16.2	20.6	16.2	20.6			68
VII	-	-	10.5	26.3	14.0	17.5	31.6			57
VIII	-	-	8.1	17.2	27.6	23.0	17.2			87
IX	-	-	16.7	33.3	-	33.3	16.7			6

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Tables 11-12

Table 11 : Core and Flake Components of the Industry, by Edges (Per cent)

Horizon	Core or Lump	Flake	Trimming Flake	Indeterminate	Total No.
I	17.8	73.4	4.3	4.5	353
II	29.5	62.1	3.8	4.6	478
III	30.1	63.6	2.4	3.9	717
IV	22.1	72.6	2.8	2.6	580
V	32.4	60.4	2.6	4.6	719
VI	29.8	63.4	3.1	3.6	386
VII	21.7	71.1	2.3	4.9	391
VIII	34.9	57.5	1.7	6.0	482
IX	37.3	61.4	-	5.3	75

Table 12 : Condition of Edges (Per cent)

Horizon	Whole	Probably Whole	Not Whole	Indeterminate	Total No.
I	9.6	40.5	9.9	39.9	353
II	6.5	37.5	11.1	45.0	478
III	5.6	43.2	10.2	41.0	717
IV	2.9	40.5	11.7	44.8	580
V	6.8	42.3	10.9	40.1	719
VI	7.5	41.2	9.6	41.7	386
VII	4.9	36.8	11.8	46.6	391
VIII	5.0	40.9	8.7	45.4	482
IX	18.7	48.0	-	33.3	75

Table 13(a) : Base Types, in Relation to Edges (Per cent)

Horizon	Indeter- minate	Pebble Cortex	Other Cortex	Break	Negative Bulb	Positive Bulb	Not Applicable	Total No.
I	8.2	4.8	6.0	5.1	18.4	43.9	13.6	353
II	2.5	8.0	8.0	5.0	18.6	48.1	9.8	478
III	2.4	7.5	9.1	3.9	23.2	47.6	6.4	717
IV	2.9	6.9	3.8	2.4	23.8	55.2	5.0	580
V	1.7	7.0	7.2	3.8	23.6	50.1	6.7	719
VI	2.1	7.0	4.7	5.4	26.7	46.6	7.5	386
VII	2.1	3.8	4.9	3.1	19.7	57.8	8.7	391
VIII	2.9	13.3	1.5	4.6	21.4	48.1	8.3	482
IX	5.3	20.0	4.0	4.0	24.0	20.0	22.7	75

Table 13(b) : Base Types in Relation to Implements (Per cent)

Horizon	Indeter- minate	Pebble Cortex	Other Cortex	Break	Negative Bulb	Positive Bulb	Not Applicable	Total
I	6.7	6.7	6.1	5.5	14.6	43.3	17.1	164
II	4.0	8.4	8.9	5.3	16.8	46.0	10.6	226
III	3.1	7.4	7.7	3.7	21.7	47.3	9.1	351
IV	2.5	6.3	3.5	2.8	20.4	58.8	5.6	284
V	1.5	7.7	7.7	4.3	20.0	49.2	9.5	325
VI	2.6	8.9	4.7	6.8	22.4	44.8	9.9	192
VII	3.6	5.5	4.2	5.5	16.4	56.4	8.5	165
VIII	4.0	14.4	2.0	5.5	17.8	47.5	8.9	202
IX	4.4	13.3	4.4	6.7	28.9	24.4	17.8	45

Table 14 : Preparatory Flaking (Per cent)

Horizon	Unclear	None	Base Struck	Side/End Struck	Not Applicable	Total No.
I	13.6	38.0	34.6	0.3	13.6	353
II	15.3	33.7	41.0	-	10.0	478
III	20.6	25.8	46.7	0.4	6.4	717
IV	14.7	28.8	51.2	0.2	5.2	580
V	16.0	31.0	45.3	0.4	2.7	719
VI	13.2	32.4	46.3	-	7.5	386
VII	16.9	22.8	51.4	0.3	8.7	391
VIII	14.5	30.1	46.9	0.2	8.3	482
IX	4.0	37.3	36.0	-	22.7	75

Table 15(a) : Shape of 'Whole' Edges (Per cent)

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	32.4	41.2	26.5	-	34
II	32.3	51.6	16.1	-	31
III	22.5	65.0	12.5	-	40
IV	29.4	64.7	5.9	-	17
V	30.6	51.0	18.3	2.0	49
VI	24.1	65.5	10.3	-	29
VII	36.8	47.4	15.8	-	19
VIII	20.8	66.7	12.5	-	24
IX	28.6	42.9	21.4	7.1	14

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Tables 14-15

Table 15(b) : Shape of 'Probably Whole' Edges (Per cent)

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	25.2	65.0	9.8	-	143
II	25.7	63.7	10.6	-	179
III	23.9	70.7	4.5	1.0	310
IV	23.4	69.4	6.8	0.4	235
V	26.3	67.8	5.9	-	304
VI	28.3	66.7	5.0	-	159
VII	20.1	72.9	6.9	-	144
VIII	20.8	70.1	8.6	0.5	197
IX	16.7	77.8	5.6	-	36

Table 16(a) : Length of Straight 'Whole' and 'Probably Whole' Edges (Per cent)

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	12.8	46.8	27.7	10.6	2.1	-	-	-	47
II	3.6	41.1	35.7	14.3	3.6	-	1.8	-	56
III	3.6	45.7	33.7	10.8	3.6	1.2	1.2	-	83
IV	-	51.6	26.7	15.0	5.0	-	1.7	-	60
V	6.3	44.2	27.4	13.7	3.2	3.2	1.1	1.1	95
VI	13.5	36.6	30.8	15.4	-	3.8	-	-	52
VII	5.6	47.2	25.0	19.5	-	-	2.8	-	36
VIII	10.9	41.3	32.6	10.9	4.3	-	-	-	46
IX	10.0	30.0	30.0	20.0	10.0	-	-	-	10

Table 16(b) : Length of Concave 'Whole' and
'Probably Whole' Edges (Per cent)

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	4.7	44.8	33.6	14.0	0.9	0.9	-	-	107
II	2.3	48.4	33.8	12.3	1.5	1.5	-	-	130
III	3.3	44.8	35.8	14.8	1.6	0.4	-	-	245
IV	1.7	43.1	36.2	13.8	3.4	1.5	-	0.6	174
V	4.3	42.9	34.6	12.4	3.9	0.9	-	-	231
VI	5.6	42.4	33.6	13.2	2.4	0.8	-	-	125
VII	2.6	41.2	36.0	16.7	2.6	0.9	-	-	114
VIII	2.6	44.7	33.8	10.4	4.5	3.2	0.6	-	134
IX	-	50.0	32.4	-	17.6	-	-	-	34

Table 16(c) : Length of Convex 'Whole' and
'Probably Whole' Edges (Per cent)

Horizon	Length in mm.								Total No.
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	-	17.4	30.4	34.8	8.7	8.7	-	-	23
II	4.2	8.3	29.2	23.3	8.3	8.3	-	8.3	24
III	5.3	13.8	36.8	26.3	10.5	5.3	-	-	19
IV	-	23.6	29.4	29.4	11.8	5.9	-	5.9	17
V	-	15.4	19.2	34.6	15.4	3.8	-	11.5	26
VI	-	18.2	36.4	18.2	18.2	-	9.1	-	11
VII	-	-	7.7	46.2	7.7	7.7	15.4	15.4	13
VIII	-	5.0	35.0	25.0	15.0	15.0	5.0	-	20
IX	-	-	-	-	80.0	20.0	-	-	5

Table 17 : Indentation Index of 'Whole' and
'Probably Whole' Concave Edges (Per cent)

Horizon	Lc/D					Total No.
	<3.3	3.3-4.9	5.0-9.9	10.0-19.9	>19.9	
I	0.9	10.3	56.1	32.7	-	107
II	2.3	10.0	63.1	21.5	3.1	130
III	2.5	9.8	63.6	22.5	1.6	245
IV	1.2	8.6	54.6	34.4	1.2	174
V	0.9	11.3	57.6	29.4	0.9	231
VI	0.8	12.0	54.4	30.4	2.4	125
VII	0.9	4.4	69.3	24.6	0.9	114
VIII	0.6	11.0	57.8	25.4	5.2	154
IX	-	17.7	52.9	26.4	2.9	34

Table 18 : Projection Index of 'Whole' and
'Probably Whole' Convex Edges (Per cent)

Horizon	Lc/D					Total No.
	<3.3	3.3-4.9	5.0-9.9	10.0-19.9	>19.9	
I	-	13.0	43.5	30.4	13.1	23
II	4.2	-	16.7	62.5	16.7	24
III	-	5.3	47.4	36.8	10.5	19
IV	-	5.9	29.4	52.9	11.8	17
V	-	7.7	34.6	50.0	7.7	26
VI	-	9.1	27.3	45.4	18.2	11
VII	-	-	46.2	23.1	30.8	13
VIII	-	10.0	35.0	40.0	15.0	20
IX	-	-	40.0	-	60.0	5

Table 19 : Retouch Type (Per cent)

Horizon	None	Step Flaking		Other Unifacial Flaking	Bifacial Flaking	Other	Total No.
		Light	Heavy				
I	49.9	39.9	8.2	2.0	-	-	353
II	36.0	54.6	7.5	1.7	0.2	-	478
III	34.3	57.5	6.0	2.2	-	-	717
IV	30.0	60.9	6.2	2.9	-	-	580
V	31.4	58.0	8.1	2.4	0.1	-	719
VI	28.0	63.2	5.2	3.4	0.3	-	386
VII	33.5	57.0	7.4	2.1	-	-	391
VIII	35.3	56.9	5.8	1.9	0.2	-	482
IX	52.0	42.7	1.3	2.7	1.3	-	75

Kafilauna
Table 19

Tables 20 : Angle of Edge on Retouched Edges (Per cent)

Table 20(a) : Light Step Flaking

Horizon	Angle (degrees)									Total No.	
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	90-9		
I	-	-	3.6	9.2	29.1	36.2	14.2	6.4	6.4	1.4	141
II	-	-	1.2	13.4	24.9	31.4	18.8	8.1	8.1	2.3	261
III	-	0.2	1.9	8.3	29.4	35.0	18.2	4.9	4.9	2.2	412
IV	-	-	1.4	6.2	28.3	36.0	20.7	5.4	5.4	2.0	353
V	-	-	1.7	6.7	19.4	36.9	22.3	9.6	9.6	3.4	417
VI	-	-	0.8	7.8	23.8	34.8	20.5	8.2	8.2	4.1	244
VII	-	-	1.8	6.7	22.4	30.0	25.1	9.9	9.9	4.0	223
VIII	-	-	0.7	6.9	23.7	31.8	29.9	4.4	4.4	2.6	274
IX	-	-	6.3	12.5	53.1	18.8	9.4	-	-	-	32

Kafiyavana
Table 20(a)

Table 20(b) : Heavy Step Flaking

Horizon	Angle (degrees)									Not Meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	90-9		
I	-	-	-	3.5	20.7	37.9	31.0	-	-	6.9	29
II	-	-	-	11.1	22.2	30.6	19.4	5.6	-	11.1	36
III	-	-	-	-	23.3	32.6	23.3	11.6	-	9.3	43
IV	-	-	5.6	-	22.2	47.2	19.4	2.8	-	2.8	36
V	-	-	-	-	3.5	20.7	43.1	22.4	-	3.5	58
VI	-	-	-	-	-	20.0	10.0	65.0	-	5.0	20
VII	-	-	-	-	3.5	31.0	37.9	24.1	-	-	29
VIII	-	-	-	-	3.6	32.1	46.4	17.9	-	-	28
IX	-	-	-	-	-	-	100.0	-	-	-	1

Table 20(c) : Other Unifacial Flaking

Horizon	Angle (degrees)									Not Meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9	90-9		
I	-	14.3	14.3	14.3	28.6	14.3	14.3	-	-	-	7
II	12.5	12.5	50.0	-	12.5	12.5	-	-	-	-	8
III	-	6.3	21.3	18.8	12.5	25.0	6.3	-	-	-	16
IV	-	-	23.5	41.2	35.5	-	-	-	-	-	17
V	-	23.5	23.5	23.5	17.7	5.9	-	-	-	-	17
VI	-	7.7	23.1	46.2	23.1	-	-	-	-	-	13
VII	-	-	25.0	37.5	12.5	12.5	12.5	-	-	-	8
VIII	-	11.1	22.2	44.4	11.1	11.1	-	-	-	-	8
IX	-	-	50.0	50.0	-	-	-	-	-	-	2

Table 21 : Types of Use-Wear (Per cent)

Horizon	None	Chattering	Bifacial	Utilisation	Total No.
I	33.4	46.2	0.6	19.8	353
II	46.0	39.1	-	14.9	478
III	43.9	46.6	-	9.5	717
IV	47.8	43.8	-	8.5	580
V	49.7	40.3	0.1	9.9	719
VI	45.3	46.4	-	8.3	386
VII	43.5	46.3	0.3	10.0	391
VIII	43.0	45.0	0.8	11.2	482
IX	37.3	37.3	-	25.3	75

Kafiyana
Table 21

Tables 22 : Shape of 'Whole' and 'Probably Whole'
Lengths of Use-Wear (Per cent)

Table 22(a) : 'Chattering'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	29.8	66.7	3.6	-	84
II	41.9	54.8	3.2	-	93
III	39.2	59.7	1.1	-	176
IV	32.3	62.4	5.3	-	133
V	38.1	58.6	3.2	-	155
VI	41.2	55.9	2.9	-	102
VII	40.0	57.8	2.2	-	90
VIII	32.3	64.5	3.2	-	124
IX	14.3	85.7	-	-	21

Table 22(b) : 'Utilisation'

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	35.8	28.3	35.8	-	53
II	32.1	30.2	37.8	-	53
III	46.9	22.4	28.6	2.0	49
IV	51.6	25.8	22.6	-	31
V	54.4	14.1	29.8	1.8	57
VI	37.1	37.1	25.9	-	27
VII	34.5	31.0	34.5	-	29
VIII	21.6	40.6	37.8	-	37
IX	35.7	21.4	35.7	7.1	14

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Tables 22

Tables 23 : Lengths of 'Whole' and 'Probably
Whole' Lengths of Use-Wear (Per cent)

Table 23(a) : 'Chattering'

Horizon	Length in mm.								Total No.
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	16.7	70.2	7.1	3.6	1.2	1.2	-	-	84
II	18.3	58.1	19.4	3.2	-	1.1	-	-	93
III	17.6	56.2	22.2	2.8	0.6	-	-	-	176
IV	11.3	59.4	21.8	6.0	1.5	-	-	-	133
V	20.0	58.7	15.5	4.5	0.6	0.6	-	-	155
VI	21.6	58.8	12.8	4.9	-	1.0	-	-	102
VII	20.0	58.9	16.7	4.4	-	-	-	-	90
VIII	23.4	55.7	16.1	4.0	-	0.8	-	-	124
IX	9.5	61.9	23.8	-	4.8	-	-	-	21

Table 23(b) : 'Utilisation'

Horizon	Length in mm.								Total No.
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
I	-	26.4	37.8	28.3	1.9	5.7	-	-	53
II	1.9	13.2	34.0	32.1	7.5	5.7	3.8	3.8	53
III	2.0	26.5	28.6	26.5	10.2	4.1	2.0	-	49
IV	-	9.7	35.5	29.0	16.1	3.2	3.2	3.2	31
V	1.8	21.1	26.3	21.1	14.1	8.8	1.8	5.3	57
VI	-	11.1	44.4	22.2	14.8	3.7	3.7	-	27
VII	-	17.3	24.2	34.5	3.5	3.5	10.3	6.9	29
VIII	2.7	8.1	37.8	16.2	16.2	16.2	2.7	-	37
IX	-	14.3	28.6	7.1	42.8	7.1	-	-	14

Kafayana
Tables 23

Tables 24 : Indentation Index for 'Whole' and
'Probably Whole' Concave Lengths of Use-Year (Per cent)

Table 24(a) i 'Chattering'

Horizon	Lc/D						Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9		
I	3.9	10.7	64.2	20.7	-	56	
II	4.8	12.2	69.4	14.3	-	49	
III	2.9	10.9	71.3	14.9	-	101	
IV	3.7	9.8	63.4	23.2	-	82	
V	2.2	12.2	63.4	22.2	-	90	
VI	-	14.3	67.8	17.9	-	56	
VIII	4.0	8.0	66.0	22.0	-	50	
VIII	-	14.3	67.5	16.9	1.3	77	
IX	-	16.7	66.7	16.7	-	18	

Table 24(b) i 'Utilisation'

Horizon	Lc/D						Total No.
	0-3.3	3.4-4.9	5.0-9.9	10.0-19.9	>19.9		
I	-	6.7	46.7	46.7	-	15	
II	6.3	12.5	37.5	31.2	12.5	16	
III	9.1	-	36.4	36.4	18.2	11	
IV	-	-	12.5	75.0	12.5	8	
V	-	12.5	50.0	25.0	12.5	8	
VI	-	-	10.0	70.0	20.0	10	
VII	-	-	33.3	55.5	11.1	9	
VIII	-	-	26.6	33.3	33.3	15	
IX	-	6.7	33.3	33.3	33.3	3	

Tables 25 : Relationship of Retouch Type and Edge Shape on 'Whole' and 'Probably Whole' Edges (Per cent)

Table 25(a) : Edges Without Retouch

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	32.7	45.8	21.5	-	107
II	41.2	38.2	20.6	-	102
III	39.6	48.1	12.6	-	127
IV	39.8	48.9	11.3	-	88
V	40.3	44.8	14.9	0.7	134
VI	39.4	48.5	12.1	-	66
VII	33.3	47.8	18.8	-	69
VIII	28.1	54.2	17.7	-	96
IX	25.0	57.2	17.8	-	28

Table 25(b) : Edges with Light Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	20.0	80.0	-	-	60
II	15.1	83.8	1.1	-	93
III	15.9	83.0	1.0	-	195
IV	15.4	79.1	4.7	0.7	149
V	17.9	79.6	2.6	-	191
VI	19.6	77.6	2.8	-	107
VII	16.2	83.7	-	-	80
VIII	15.8	81.5	1.8	0.8	114
IX	14.3	85.7	-	-	21

Table 25(c) : Edges with Heavy Step Flaking

Horizon	Straight	Concave	Convex	Wavy	Total No.
I	-	100.0	-	-	10
II	-	100.0	-	-	11
III	5.0	90.0	5.0	-	20
IV	10.0	80.0	10.0	-	10
V	25.0	68.8	6.2	-	16
VI	12.5	87.5	-	-	8
VII	-	92.9	-	7.1	14
VIII	10.0	90.0	-	-	10
IX	-	-	-	-	-

Tables 26 : General Angle of Edges with Use-Wear (Per cent)

Table 26(a) : 'Chattering'

Horizon	Angle (degrees)								Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		
I	-	0.6	8.6	13.5	21.5	27.6	17.2	8.0	3.1	163
II	-	2.1	6.4	12.8	20.3	26.2	19.8	10.2	2.1	187
III	-	1.2	5.1	9.3	24.9	29.6	18.3	6.0	5.7	334
IV	-	-	2.8	5.9	24.4	31.1	24.4	7.5	3.9	254
V	-	1.4	3.8	9.3	22.8	25.2	22.4	11.0	4.1	290
VI	-	0.6	2.2	7.8	17.9	24.6	29.6	10.6	6.7	179
VII	-	-	3.3	12.7	18.8	29.8	26.5	7.7	1.1	181
VIII	0.5	1.4	3.7	8.8	18.0	36.4	20.3	5.1	6.0	217
IX	-	-	7.1	14.3	28.6	25.0	21.4	3.6	-	28

Table 26(b) : 'Utilisation'

Horizon	Angle (degrees)								Not meas.	Total No.
	20-9	30-9	40-9	50-9	60-9	70-9	80-9	90-9		
I	12.9	34.3	18.6	15.6	7.1	4.3	4.3	1.4	1.4	70
II	15.5	14.1	21.1	26.8	11.3	5.6	5.6	-	-	71
III	23.5	10.3	33.8	14.7	11.8	2.9	2.9	-	-	68
IV	8.2	16.3	26.5	32.7	14.3	2.0	-	-	-	49
V	11.3	22.5	25.4	11.3	19.7	7.0	2.8	-	-	71
VI	15.6	15.6	37.5	15.6	9.4	3.1	3.1	-	-	32
VII	7.7	25.6	28.2	12.8	12.8	2.6	2.6	5.1	2.6	39
VIII	7.4	22.2	24.1	18.5	18.5	5.6	3.7	-	-	54
IX	5.3	15.8	26.3	10.5	21.1	10.5	10.5	-	-	19

Tables 27 : Use-Wear Types in Relation to
Step-Flaking Retouch'(Per cent)

Table 27(a) : 'Chattering'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	66.7	25.0	8.3	168
II	55.1	39.6	5.3	189
III	55.0	40.1	4.9	347
IV	51.2	46.9	2.0	256
V	54.4	36.1	9.6	291
VI	42.6	53.0	4.4	183
VII	50.5	44.7	4.8	188
VIII	53.4	40.9	5.8	225
IX	69.0	24.1	6.9	29

Table 27(b) : 'Utilisation'

Horizon	Retouch Type			Total No.
	None	Step Flaking		
		Light	Heavy	
I	98.6	1.4	-	69
II	100.0	-	-	71
III	97.1	2.9	-	68
IV	100.0	-	-	49
V	98.6	1.4	-	71
VI	100.0	-	-	32
VII	100.0	-	-	39
VIII	98.1	1.9	-	54
IX	100.0	-	-	18

Tables 28 : Retouch Types in Relation to Use-Wear (Per cent)

Table 28(a) : Light Step Flaking

Horizon	Use-Wear			Total No.
	Chattering	Bifacial	Utilisation	
I	97.6	-	2.4	42
II	100.0	-	-	75
III	98.6	-	1.4	141
IV	100.0	-	-	120
V	99.1	-	0.9	106
VI	100.0	-	-	97
VII	100.0	-	-	84
VIII	98.9	-	1.1	93
IX	100.0	-	-	7

Table 28(b) : Heavy Step Flaking

Horizon	Use-Wear			Total No.
	Chattering	Bifacial	Utilisation	
I	100.0	-	-	14
II	100.0	-	-	10
III	100.0	-	-	17
IV	100.0	-	-	5
V	100.0	-	-	28
VI	100.0	-	-	8
VII	100.0	-	-	9
VIII	100.0	-	-	13
IX	100.0	-	-	2

Table 28(c) : No Retouch

Horizon	Chattering	Use-Year		Utilisation	Total No.
		Bifacial			
I	61.5	1.1		37.4	182
II	59.4	-		41.2	175
III	74.3	-		25.7	257
IV	72.8	-		27.2	180
V	69.0	0.4		20.6	229
VI	70.9	-		29.1	110
VIII	70.4	0.7		28.9	135
VIII	67.8	2.3		30.0	177
IX	52.6	-		47.4	38

Tables 29 : Implement Thickness in Relation to Retouch Type on
Wholer and Probably Wholer Implements (Per cent)

Table 29(a) : Light Step Flaking

Horizon	Not meas.	Thickness in mm.										Total No.	
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
I	-	8.0	32.0	48.0	4.0	8.0	-	-	-	-	-	-	25
II	-	2.6	28.2	23.1	35.9	7.7	8.1	-	-	-	-	-	39
III	-	8.3	22.6	38.1	16.7	8.1	8.1	-	-	-	-	-	84
IV	1.5	6.1	21.2	28.8	13.6	22.7	4.5	-	-	-	-	-	66
V	-	3.6	17.9	35.7	19.7	10.7	3.6	-	-	-	-	-	56
VI	-	-	19.6	28.3	23.9	17.4	8.7	-	-	-	-	-	46
VII	-	-	35.7	35.7	21.4	7.1	-	-	-	-	-	-	28
VIII	3.8	-	17.3	13.5	15.4	19.2	-	-	-	-	-	-	41
IX	-	-	50.0	-	50.0	-	-	-	-	-	-	-	2

Table 29(b) : Heavy Step Flaking

Horizon	Not meas.	Thickness in mm.								Total No.	
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40		>40
I	-	-	-	-	-	-	100.0	-	-	-	1
II	-	50.0	-	-	-	-	-	-	-	-	2
III	-	-	50.0	-	-	50.0	-	-	-	-	2
IV	-	-	-	-	100.0	-	-	-	-	-	1
V	-	-	100.0	-	-	-	-	-	-	-	2
VI	-	-	-	100.0	-	-	-	-	-	-	1
VIII	-	-	-	-	66.6	33.3	-	-	-	-	3
VIII	-	75.0	25.0	-	-	-	-	-	-	-	4
IX	-	-	-	-	-	-	-	-	-	-	-

Table 29(c) : No Retouch

Horizon	Not meas.	Thickness in mm.								Total No.	
		0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40		>40
I	5.6	45.8	19.5	19.5	-	4.2	2.8	2.8	-	-	72
II	5.6	19.7	23.4	22.5	18.3	2.8	-	-	-	5.6	71
III	5.3	28.9	26.3	22.4	7.9	1.3	1.3	-	-	5.3	76
IV	3.4	22.4	20.7	34.4	12.1	5.2	1.7	-	-	-	58
V	3.8	22.8	27.8	25.3	10.1	6.3	1.3	-	-	1.3	79
VI	-	44.7	26.3	18.4	7.9	2.6	-	-	-	-	38
VII	6.1	21.2	45.4	21.2	6.1	-	-	-	-	-	33
VIII	1.9	30.8	19.2	11.5	21.2	7.7	7.7	-	-	-	52
IX	-	17.7	41.2	17.7	5.9	11.8	-	5.9	-	-	17

Tables 30 : Breadth/Thickness Index in Relation to Retouch Type,
on 'Whole' and 'Probably Whole' Implements (Per cent)

Table 30(a) : Light Step Flaking

Horizon	B/Th. Index										Total No.	
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99					
I	-	-	20.0	32.0	24.0	16.0	8.0	25				
II	-	4.8	26.2	21.4	23.8	19.0	4.8	42				
III	-	3.6	17.9	20.2	27.4	21.5	11.9	84				
IV	-	3.0	27.3	24.2	19.7	12.1	13.6	66				
V	1.8	5.4	35.7	35.7	12.5	7.1	1.8	56				
VI	-	6.5	21.7	21.7	23.9	15.2	10.9	46				
VII	-	-	7.1	28.6	17.9	25.0	21.4	28				
VIII	-	4.9	12.2	17.1	35.6	17.1	12.2	41				
IX	-	-	-	-	100.0	-	-	2				

Table 30(b) : No Retouch

Horizon	B/Th. Index										Total No.	
	<0.5	0.5-0.99	1-1.49	1.5-1.99	2.0-2.49	2.5-2.99	>2.99					
I	-	2.8	25.0	6.9	16.7	11.1	37.5	72				
II	-	5.6	21.1	19.7	22.5	11.3	19.7	71				
III	-	-	6.3	20.0	18.7	24.0	30.7	75				
IV	-	5.2	15.5	13.8	22.4	25.8	17.2	58				
V	1.3	2.5	15.2	17.7	29.1	10.1	24.0	79				
VI	-	5.3	10.5	7.9	10.5	23.7	42.1	38				
VII	-	-	9.1	15.2	15.2	15.2	45.4	33				
VIII	-	7.8	3.9	15.7	21.6	23.5	27.5	51				
IX	-	5.9	5.9	35.3	-	35.3	17.7	17				

Tables 31 : Relation of Retouch Angle and Implement Weight, Using 'Whole' and 'Probably Whole' Implements (Per cent)

Implements with Light Step Flaking

Table 31(a) : Horizon I

Angle (degrees)	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
30-9										1
40-9	4.2									5
50-9		20.8								8
60-9		33.3								7
70-9		8.3	8.3	12.5						3
80-9		4.2	8.3							
90-9										24

Table 31(b) : Horizon II

Angle (degrees)	Weight in gm.									Total No.
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9	80-9	
30-9										1
40-9			2.4							8
50-9	2.4	4.8	2.4	9.5						16
60-9	7.1	4.8	7.1	2.4	7.1		9.5			10
70-9	2.4	4.8	2.4	11.9		2.4				5
80-9	2.4	2.4	4.8	2.4	2.4					2
90-9						2.4				12

Table 31(c) : Horizon III

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9	1.2	1.2	1.2	1.2						1
40-9		8.4	3.6	2.4						3
50-9		1.2	19.2	15.6	7.2	2.4	1.2		2.4	12
60-9		2.4	3.6	6.0	2.4				2.4	41
70-9		1.2	4.8	2.4					1.2	14
80-9					1.2				1.2	9
90-9						1.2			1.2	3
										<u>83</u>

Table 31(d) : Horizon IV

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9					1.6					1
40-9		4.7	4.7	1.6		1.6				5
50-9		25.0	4.7	6.3	1.6	6.3	4.7			31
60-9		9.4	4.7	9.4		3.1			3.1	19
70-9		1.6	1.6	1.6		1.6			4.7	7
80-9		1.6								1
90-9										<u>64</u>

Table 31(e) : Horizon V

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9										5
40-9	5.9	2.0			2.0					10
50-9	9.8	5.9	2.0			2.0				7
60-9		7.8			5.9					16
70-9	5.9	3.9	9.8	3.9	5.9	2.0				10
80-9	7.8	3.9	7.8							10
90-9			5.9							3
										<u>51</u>

Table 31(f) : Horizon VI

Angle (degrees)	Weight in gm.								Total No.	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9										1
40-9	2.1									9
50-9	6.3	4.2		4.2		4.2				15
60-9	8.3	6.3	6.3	2.1		4.2	2.1		2.1	16
70-9		10.4	4.2		6.3	6.3				4
80-9	4.2			2.1	2.1					4
90-9				4.2			2.1			3
										<u>48</u>

Table 31(g) : Horizon VII

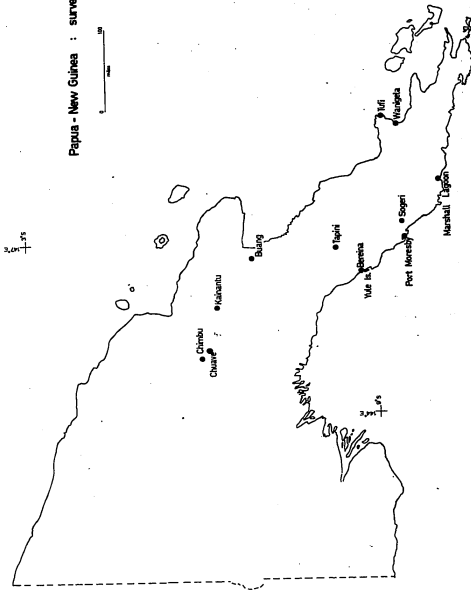
Angle (degree)	Weight in gm.								Total	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9		3.6	3.6							2
40-9		7.1	7.1	17.8		3.6				10
50-9	3.6	7.1	7.1	3.6						4
60-9					7.1			3.6	3.6	8
70-9		7.1	7.1		3.6	3.6				3
80-9		7.1		3.6						1
90-9										$\frac{1}{28}$

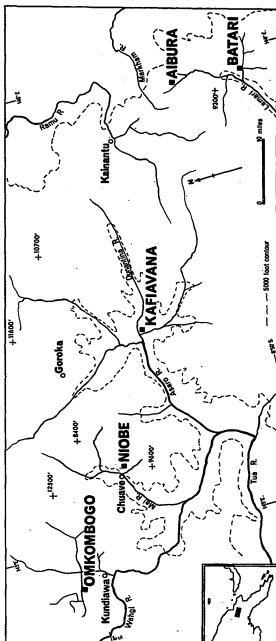
Table 31(h) : Horizon VIII

Angle (degree)	Weight in gm.								Total	
	0-9	10-9	20-9	30-9	40-9	50-9	60-9	70-9		80-9
30-9										1
40-9				2.6	2.6					8
50-9	2.6		10.4	2.6	2.6	2.6				13
60-9	18.4			13.2	2.6					14
70-9	13.2	2.6	7.9	10.5	2.6					2
80-9				2.6		2.6				2
90-9										$\frac{38}{28}$

Map 1

Papua - New Guinea : surveys.





- 1 Hamdordo
- 2 Toboalogo
- 3 Toi
- 4 Noka
- 5 Oma
- 6 Mureva
- 7 Shelters
- 8 Koba
- 9 Waru
- 10 Vefai
- 11 Ver I
- 12 Ver II
- 13 Moro
- 14 Itikinusu I
- 15 Itikinusu II
- 16 Sakurukuru
- 17 Boremanu
- 18 IFA AURUVA
- 19 MEGORIS WALL

Underlining shows sites previously recorded.

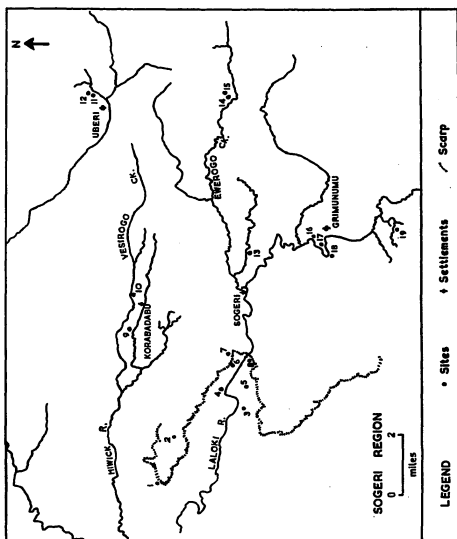
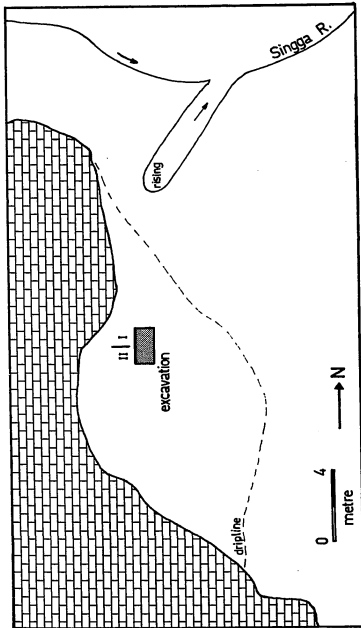


Figure 2.1

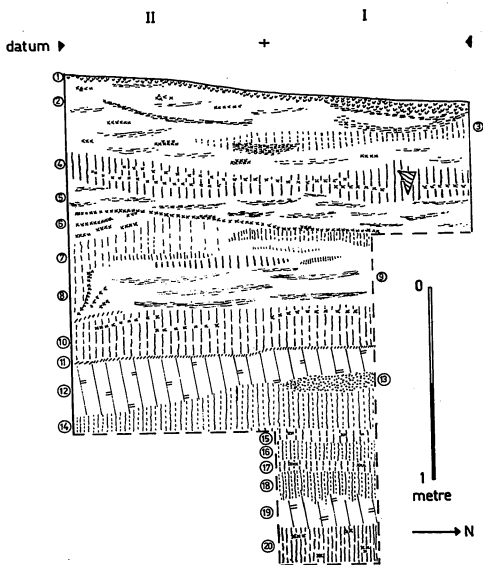


Omkombogo : plan.

Figure 2.2 - Onkomboqo
Stratigraphy of west wall

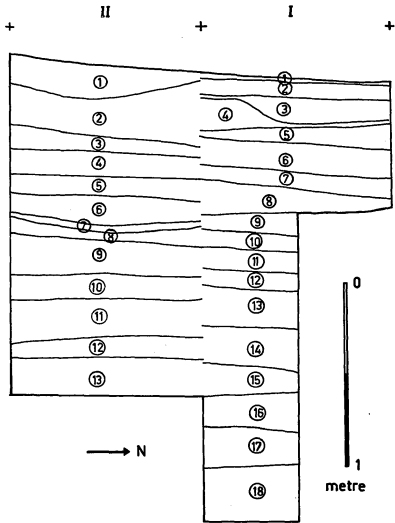
1. Vegetable material
2. White ash and carbon in grey matrix
3. Grey-brown silt
4. Brown soil and carbon
5. Layered white and cream ash lenses
6. Carbon in grey-brown silt
7. Brown and cream sediment with ashy lenses
8. Carbon-lined depression - burned tree root?
9. White and cream ash lenses
10. Brown, orange and creamy silt with carbon
11. Orange-brown ?clay
12. Yellow ?clay
13. White stony sand
14. Brown-dark grey silt
15. Dark brown silt and carbon
16. Brown-dark grey silt
17. Dark brown silt and carbon
18. Grey silt
19. Yellow ?clay
20. Grey silt and carbon

Figure 2.2



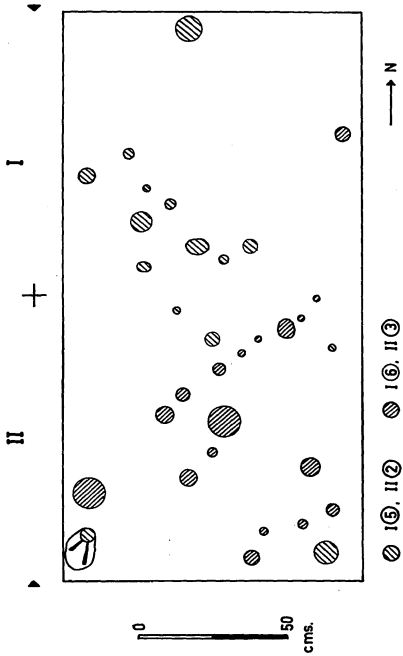
Omkombogo : west wall.

Figure 2.3



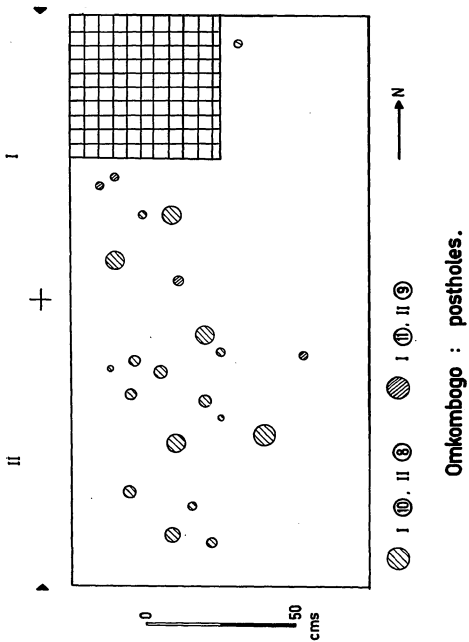
Ombombongo : excavation units.

Figure 2.4



Omkombogo : postholes.

Figure 2.5



Omkombogo : postholes.

Figure 3.1

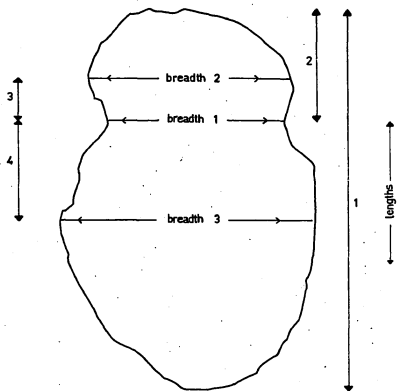
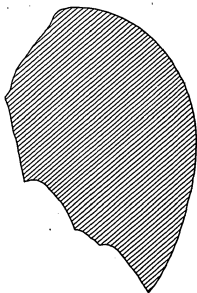
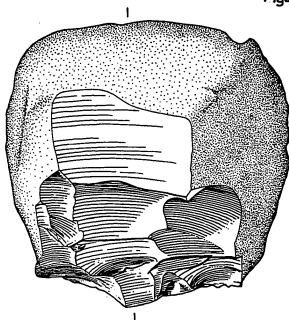


Figure 3·2



WIM

Figure 3 · 3

Diagram showing method of drawing
pebble tools and flaked implements.

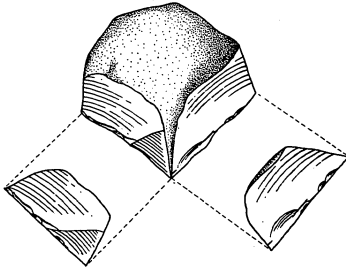


Figure 4.1

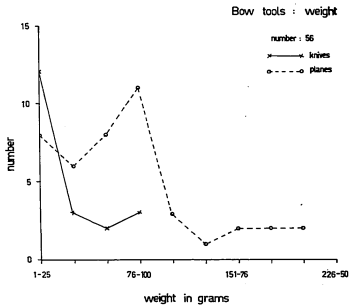
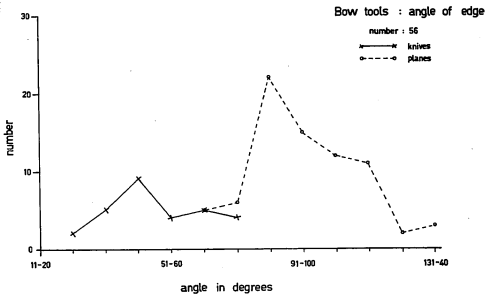


Figure 4.2

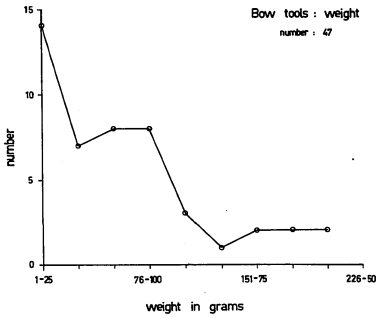
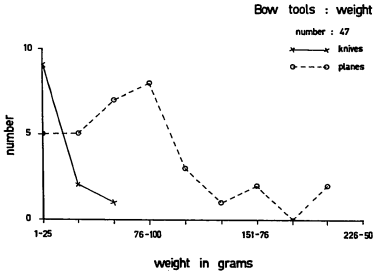


Figure 5-1

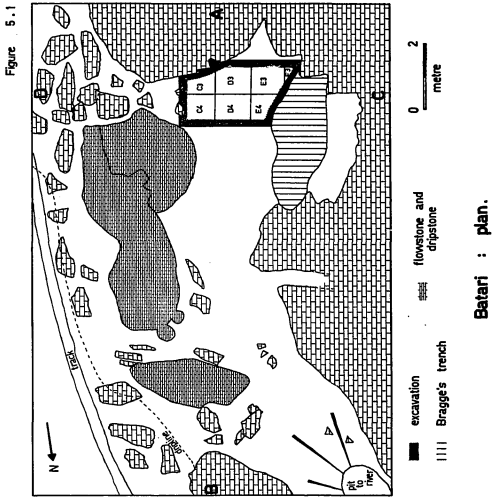
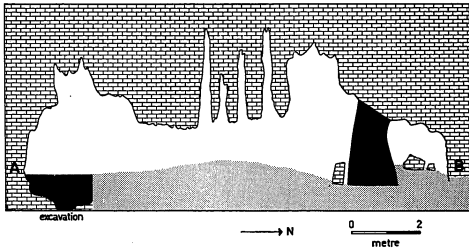
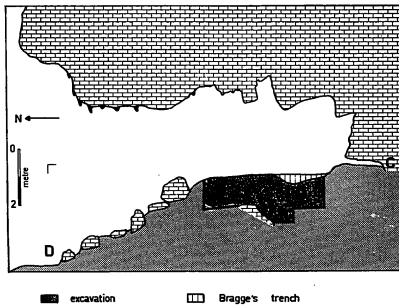


Figure 5.2



Batari : section AB

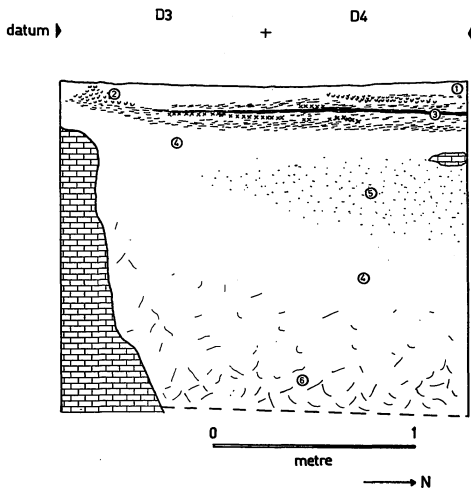


Batari : section CD

Figure 5.3 - Natari
Stratigraphy of west wall D3-D4

1. Disturbed grey silt
2. Vegetable matter
3. Ash and burnt sediment with carbon. 10 YR 4/2 - 7/2.
Hard burnt crust at centre of this layer
4. Fine silt. 10 YR 6/2 - 5/3
5. Very fine silt. 10 YR 7/2
6. Fine silt with 'frosting' concretion. 10 YR 4/3 -
3/3

Figure 5.3



Batari : west wall D3-D4.

Figure 5.4 - Batari

Stratigraphy of north wall C4 - E4

1. Disturbed grey silt
2. Ash and burnt sediment with carbon. 10 YR 8/1 - 3/2. Hard burnt crust at centre of this layer
3. Bragge's trench
4. Fine silt. 10 YR 6/2 - 5/3
5. Very fine silt. 10 YR 7/2
6. Fine silt with 'frothing' concretions. 10 YR 4/3
7. Loose silt with yellow flecks, rootlets and pebbles. 10 YR

3/3

Figure 5.4

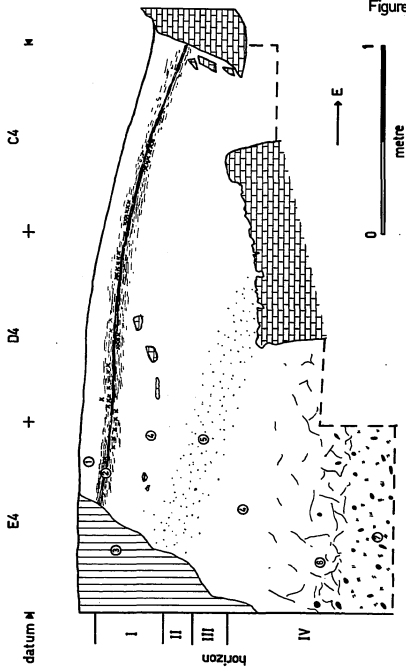


Figure 5.4

Batari : north wall C4-E4

Figure 5.5

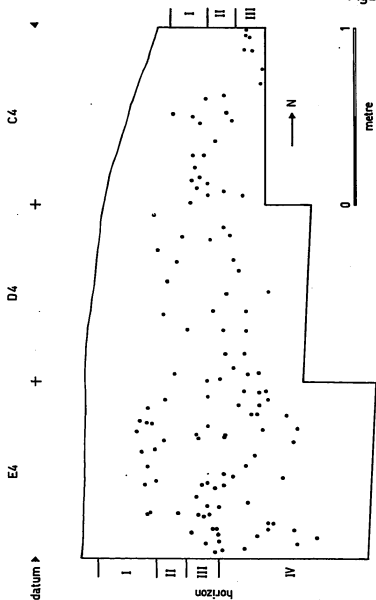


Figure 5.5

Batari : implement scatter.

Implements from C4 - E4 plotted onto northern wall.

Figure 5.6

Batari : angle of use-wear

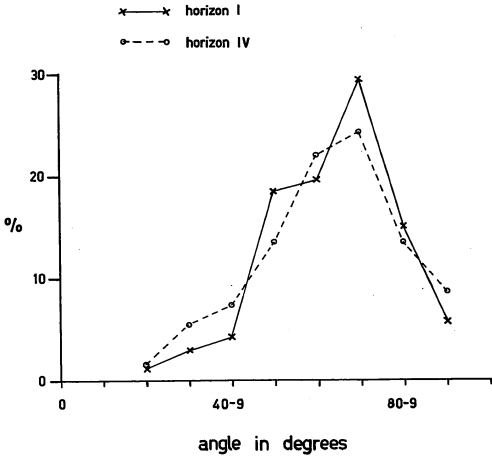


Figure 5.7 - Batari

Scale 3:2

- a. Bone awl. Unstratified
- b. Bone bipoint. D3/(7)
- c. Thin, medium bone point, class 2. E4/(9)
- d. Fine bone point, class 3. E4/(2)
- e. Ground hornfels cylinder. Unstratified
- f. Broad, heavy bone point, class 1. Unstratified
- g. Tapered calcite cylinder. Unstratified
- h. Drilled fragment of shell. D4/(4)
- i. Broken, ground limestone 'bead'. C4/(4)
- j. Shell 'bead'. Unstratified

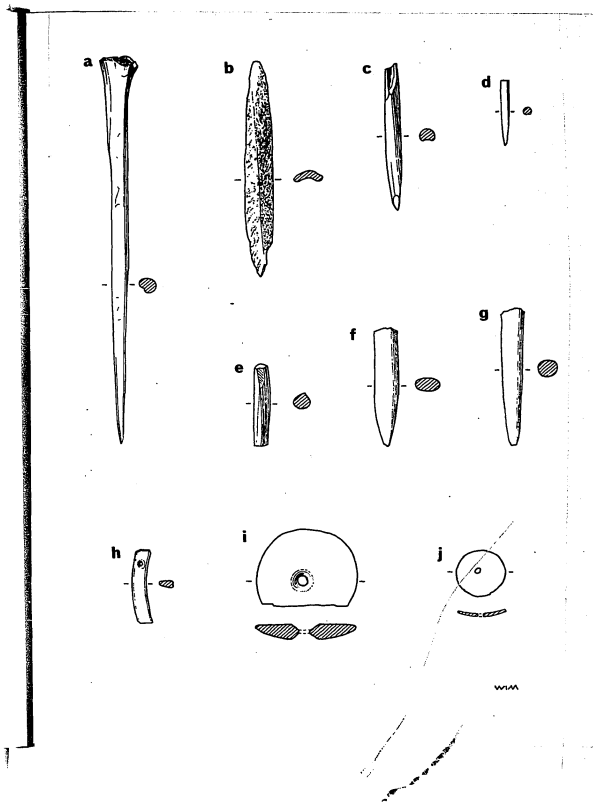


Figure 5.8 - Batari

Scale 1:1

**Pecked and ground hornfels axe-adze. South entrance,
unstratified surface.**

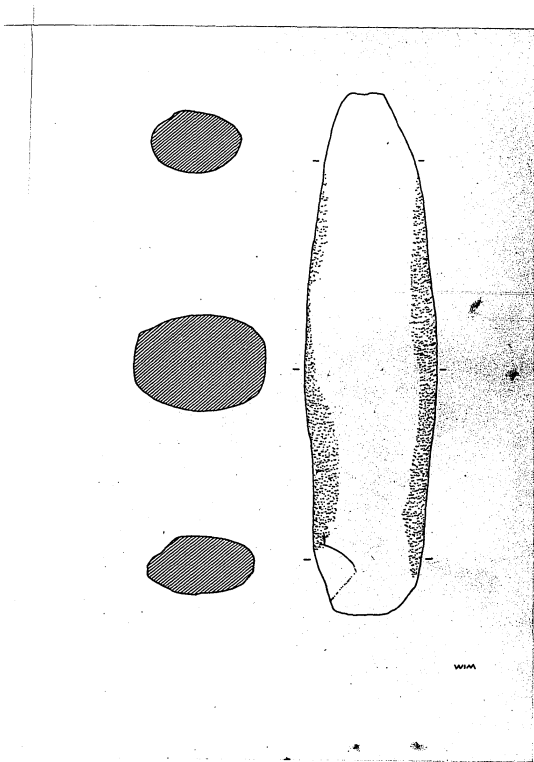
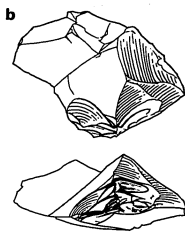
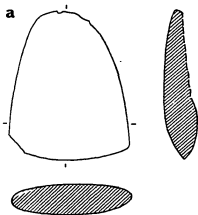


Figure 5.9 - Batari

- a. Ground stone axe-adse. Unstratified. Scale 1:1
- b. 'Trimming' flake. E4/(9)/xiii. Scale 3:2
- c. Multiplane scraper; seven altered edges.
76.E3/(11). Scale 3:2



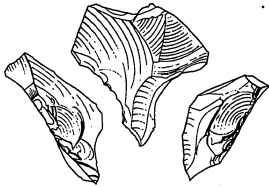
www

Figure 5.10 - Batari

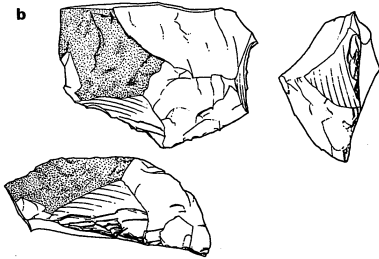
Scale 3:2

- a. Double concave scraper; four altered edges.
55.DJ/8)
- b. Side and end scraper; five altered edges. 18.FJ/3)

a



b

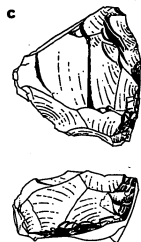
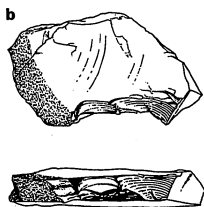
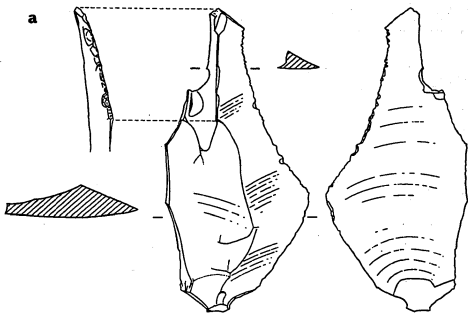


WIM

Figure 5.11 - Entari

Scale 3:2

- a. Utilized flake; four altered edges. 129.E3/(15)
- b. Side scraper; one altered edge. 62.E3/(9). See also Plates 5-8 and 5-9
- c. Multiplane scraper; eight altered edges. 33.F3/(4). See also Plate 5-7

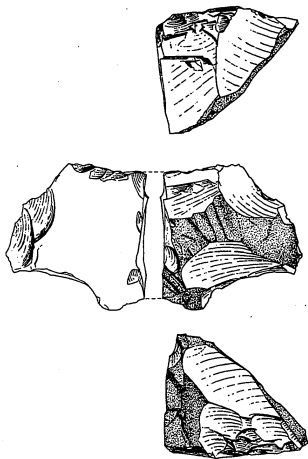


WIA

Figure 5.12 - Batavi

Scale 3:2

Double side scraper showing some bifacial retouch; three altered edges. 41.D3/(7)



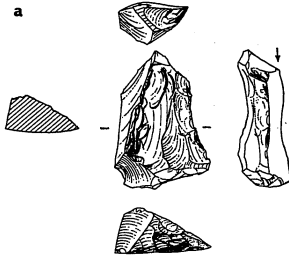
WIA

Figure 5.13 - Bataari

Scale 3:2

- a. Multiplane scraper on trimming flake; nine altered edges. 120.E3/(13)
- b. Side and end scraper; four altered edges. 38.D3/(7)

a

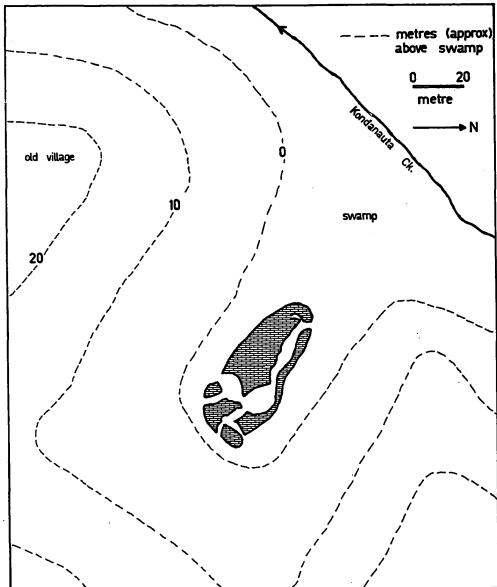


b



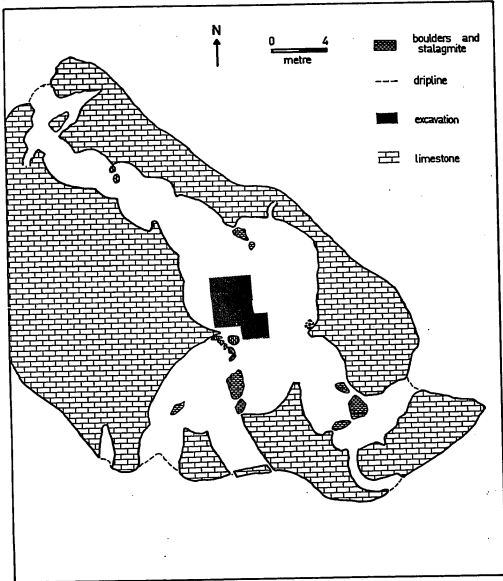
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Figure 6.1



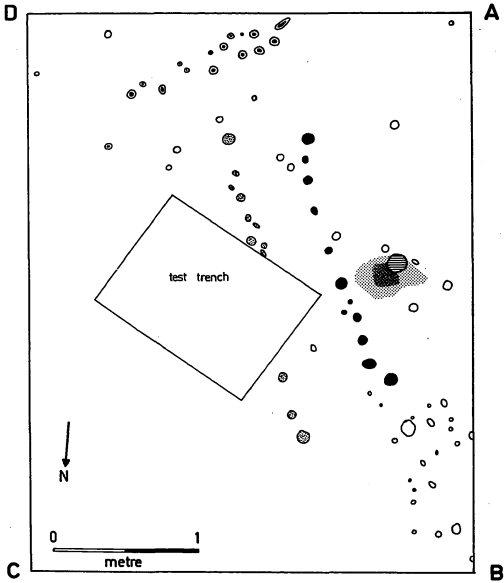
Aibura : sketch map.

Figure 6.2



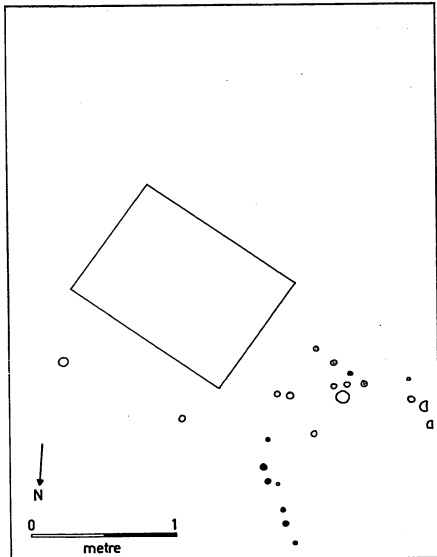
Aibura : plan of cave .

Figure 6.3



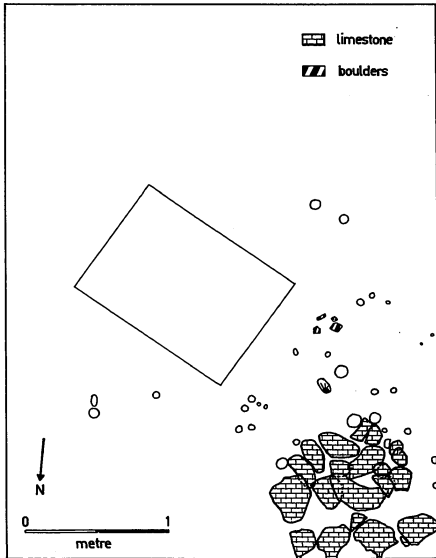
Aibura : postholes, level 1.

Figure 6.4



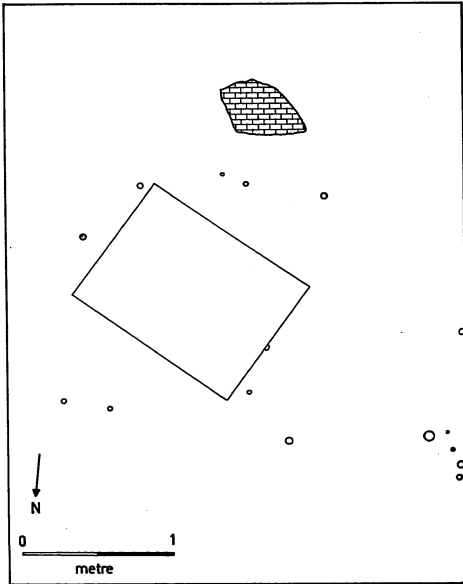
Aibura : postholes, level 2.

Figure 6.5



Aibura : postholes and rocks, level 3.

Figure 6.6



Aibura : postholes, level 4 .

Figure 6.7 - Aibura

Stratigraphy along section AB

1. Carbon and white ash
 2. White ash
 3. Grey clay. 5 YR 4/1
 4. Disturbed
 5. Burnt brown silt. 7.5 YR 5/4
 6. Fine black silt
 7. Thin reddish hearth. 5 YR 5/3
 8. Fine concreted ash
 9. Fine light brown silt. 5 YR 4/2
 10. Hard reddish-brown sterile sediment
-

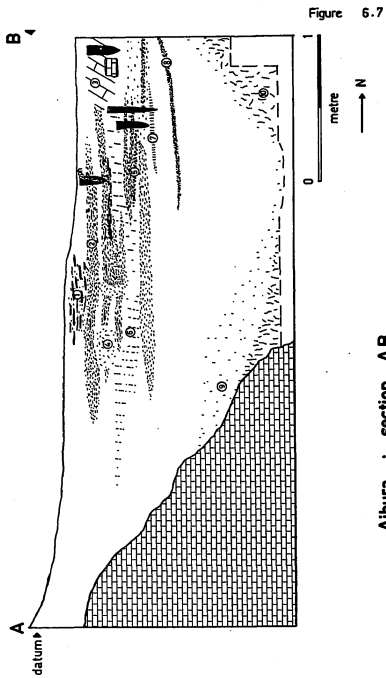
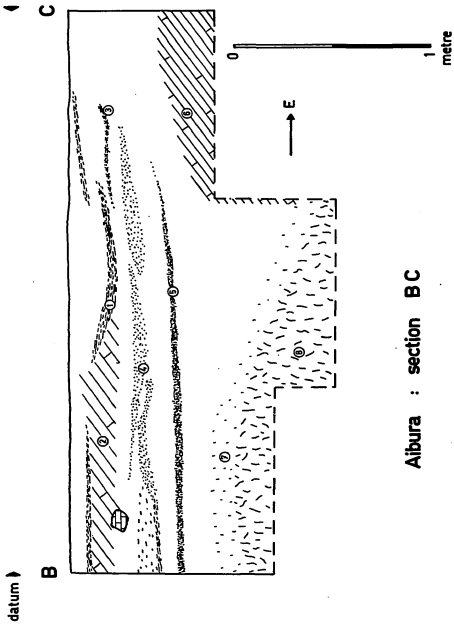


Figure 6.8 - Aibura

Stratigraphy along section BC

1. White ash
 2. Grey clay. 5 YR 4/1
 3. Fine yellow tash with carbon. 10 YR 5/6
 4. Bright red burnt sediment. 2.5 YR 4/6
 5. Fine concreted ash
 6. Clay, 10 YR 3/2 at top grading to 2.5 YR 4/4 at base
 7. Fine light brown silt. 5 YR 4/2
 8. Hard reddish-brown sterile sediment
-

Figure 6.8

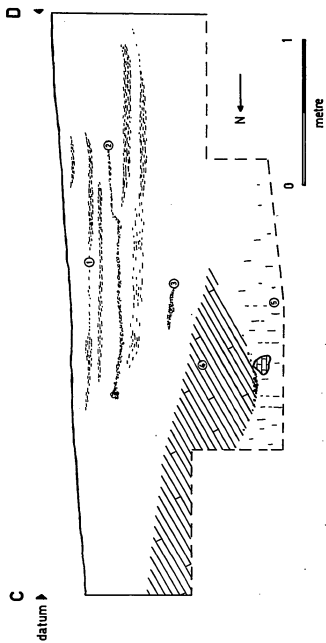


Aibura : section BC

Figure 6.9 - Albura
Stratigraphy along section CD

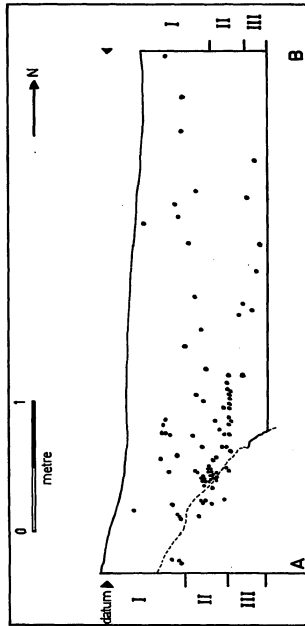
1. White ash
2. Concretion
3. Concreted white ash
4. Clay, 10 YR 3/2 at top grading to 2.5 YR 4/3 at base; small stones along basal level
5. Soft black silt. 10 YR 2/1

Figure 6.9



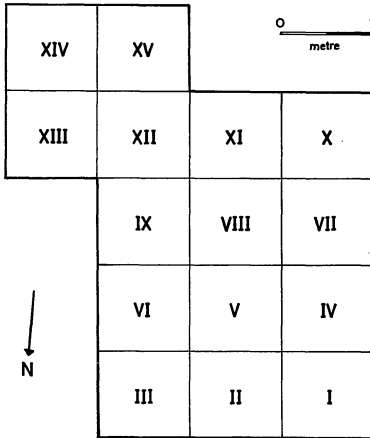
Aibura : section CD.

Figure 6.10



Aibura : implements from four western squares plotted on AB.

Figure 6·11



Aibura : numbering of excavated squares.

Figure 6.12 - Albura

Scale 3:2

- a. Bone 'head'. 87.XII/(4)
- b. Shell 'head'. 76.IV/(4)
- c. Shell 'head'. 19.XII/(3)
- d. Dered cuscus incisor. XV/(1)
- e. Bone bipoint. 42.VI/(3)
- f. Calcite bipoint. 233.XV/(2)
- g. Pierced metapodial. XII $\frac{1}{2}$ /(3)
- h. Bird bone with V-sectioned groove ground centre.
XIV/(3)
- i. Metapodial ground to a point. XI/(2)
- j. Rib section with drilled hole. V/(7)
- k. Broken bone needle. XII/(2)
- l. Bone point. 129.XII/(5)
- m. Ground shaft of bone. X/(3)
- n. Bone point. 230.XV/(1)

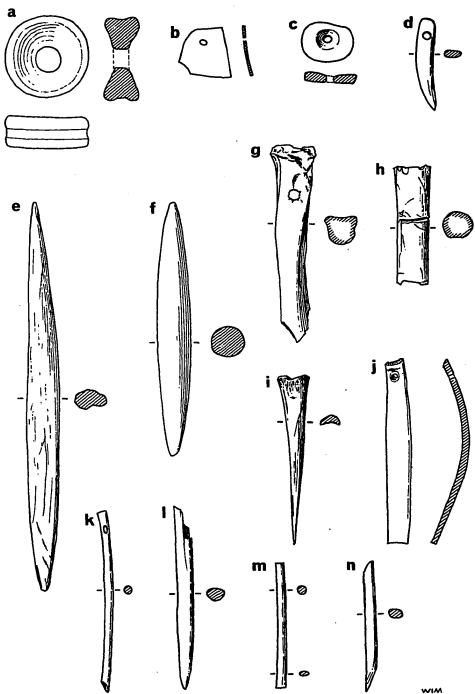
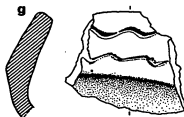
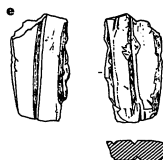
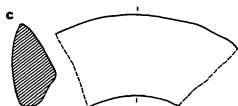
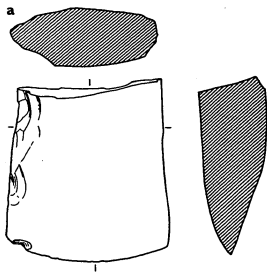


Figure 6.13 - Aibura

Scale 1:1

- a. Cutting edge and part of body of ground stone
axe-adse. 249.XV/(3)
- b. Small, ground stone, planilateral-sectioned,
axe-adse. 254.XV/(6)
- c. Fragment of marble annulus. 82.VII/(4)
- d. Fragment of marble annulus. 246.XIV/(3)
- e. Grooved and snapped piece of calcite. 4.IX/(1)
- f. Rim-herd. XII/(3)
- g. Decorated rim-herd. X/(4)



WGA

Figure 6.14 - Aibura

- a. Ground stone ?axe-adse, showing gum, and crushing on left side. 217.IV/(7). Scale 1:1
- b. Side scraper; three altered edges. 21/14, test trench 90-105 cm. Scale 3:2

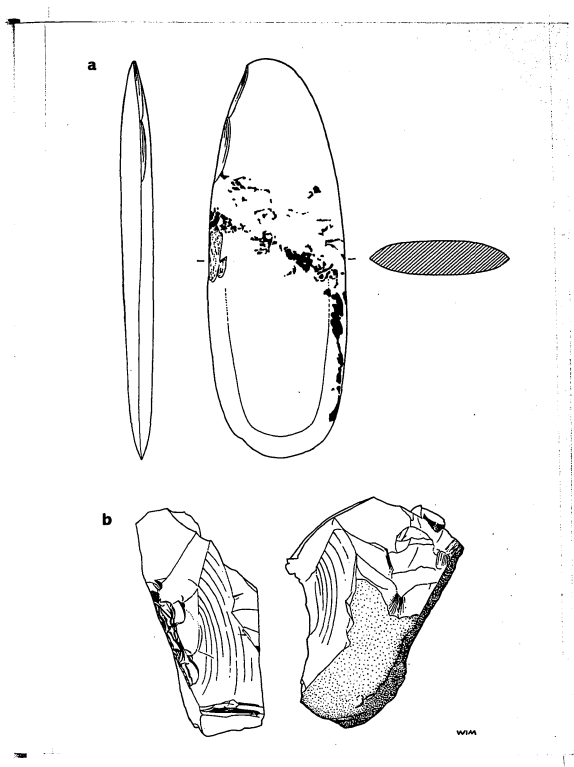
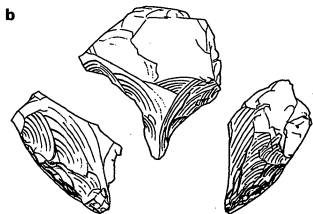
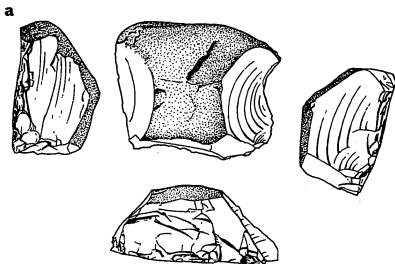


Figure 6.15 - Aikawa

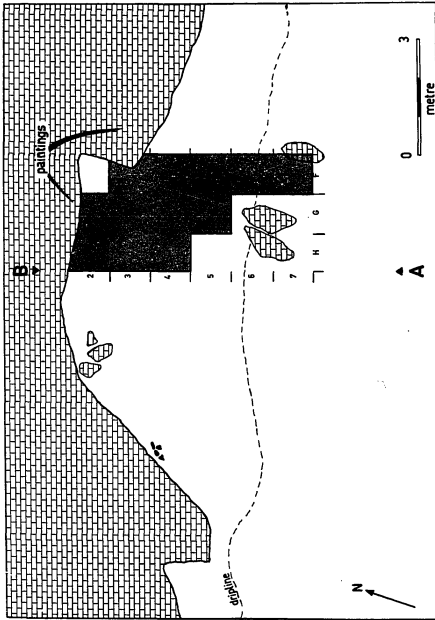
Scale 3:2

- a. Double side and end scraper; four altered edges.
108.XI/(4)
- b. Double concave scraper; five altered edges.
205.VIII/(8)



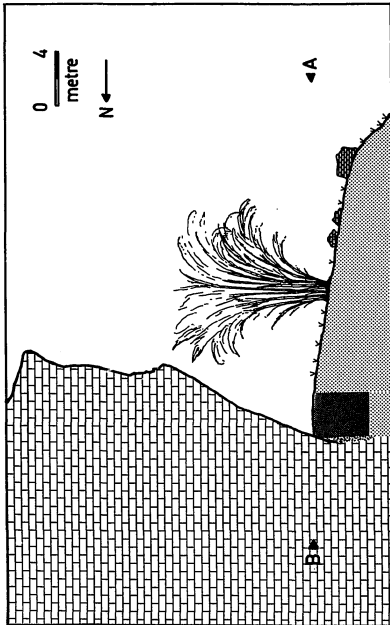
WMA

Figure 7.1



Kafiavana : plan.

Figure 7.2



Kafiavana : section.

Figure 7.3 - Kafivava
Stratigraphy of east wall F4-F7,
and south wall F5

1. Light grey silt. 10 YR 5/3
- 2A Fine dry grey silt. 10 YR 4/2
- 2B Wet grey silt. 10 YR 3/2
3. Concreted grey silt
4. Hearth with carbon and stones
5. Dark grey silt. 10 YR 3/3
6. Granular sediment with small concretions; largely stone free. 10 YR 3/3
7. Harder stony clayey-silt. 10 YR 3/2
8. Roof fall fragments
9. Black silt with few stones. 10 YR 2/2
10. Dense roof fall in dark silt. 10 YR 2/2
11. Fine hard packed stone-free sediment. 10 YR 2/1
12. Clay

Figure 7.3

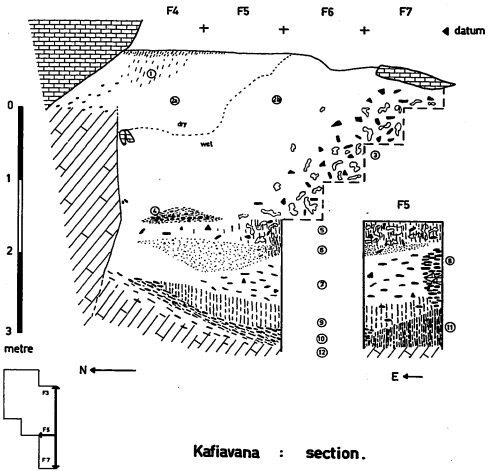


Figure 7.4 - Kafivava
Stratigraphy of west wall G2-G3
and south wall G5

1. Dark silt with matted roots. 10 YR 4/1
 2. Ash in black silt
 3. Cream ash lenses with carbon. 10 YR 6/2
 4. Hearth of leaves, creamy ash and carbon
 5. Firm fine-grained humic silt. 10 YR 2/2
 6. Grey ashy silt. 10 YR 4/1 - 6/2
 7. Granular dark stain. 10 YR 2/2
 8. Yellow-brown to dark brown silty sediment. 10 YR
3/1 - 6/2
 9. Greyish sandy silt with red speckling. 10 YR 4/3
 10. Light grey sediment with red spicules. 10 YR 4/3
 11. Fine white cream and reddish ash bands. 10 YR 4/4 -
5/2
 12. Small hearth
 13. Grey silt, heavily concreted
 14. Grey sandy silt. 10 YR 4/1
 15. Light grey silt. 10 YR 3/3
 16. Light grey silt. 10 YR 3/2
 17. Grey silt. 10 YR 4/2
 18. Fine silt. 10 YR 3/4 - 4/2
 19. Grey silt. 10 YR 3/3
 20. Fine hard packed stone-free sediment. 10 YR 2/1
 21. Tightly packed roof fall fragments
 22. Roof fall, partly mixed with clay
 23. Crumbly clay. 7.5 YR 5/6
 24. Yellow-brown clay
- ph = post holes

Figure 7.4

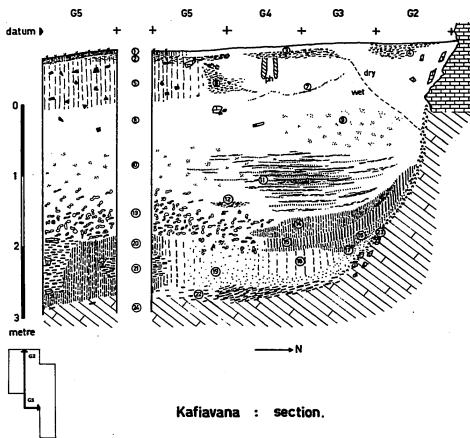
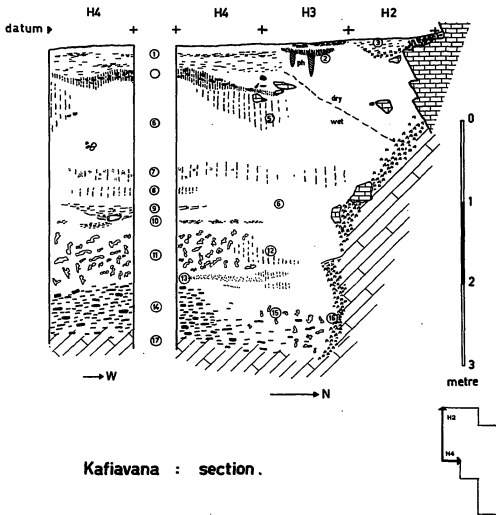


Figure 7.5 - Kafivana
Stratigraphy of west wall H2-H4
and south wall H4

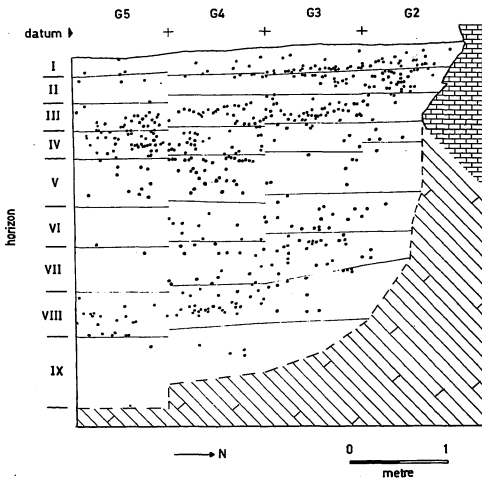
1. Fine ashy silt with buff stains. 10 YR 4/3 - 7/3
2. Small pit with carbon. 10 YR 5/1
3. Dark grey-brown ash. 10 YR 4/2
4. Hard ash with many river pebbles. 10 YR 3/2
5. Fine dark grey silt. 10 YR 2/2
6. Grey silt. 10 YR 3/3 - 4/2
7. Paler grey silt with red spicules. 10 YR 6/2
8. Darker grey silt
9. Dark ash and carbon
10. Patchy white ash with carbon spicules. 10 YR 6/2
11. Concreted grey silt. 10 YR 5/2
12. Dark grey silt
13. Fine grey granular sandy silt. 10 YR 3/3
14. Compacted roof fall in darker sediment. 10 YR 3/3
15. Concreted grey silt. 10 YR 4/3
16. Crumbly clay. 7.5 YR 4/8
17. Red-brown clay

Figure 7.5



Kafiavana : section .

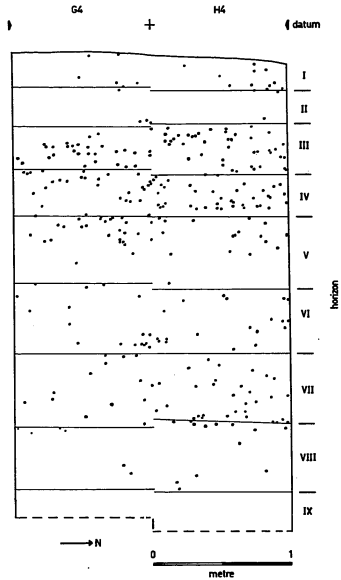
Figure 7.6



Kafiavana : implement scatter.

Implements from G2-5 plotted on western wall.

Figure 7.7



Kafiavana : implement scatter.

Implements from G4 and H4 plotted on south wall.

Figure 7.8 - Rafiayana

Weight of waste stone in each 20 cm.
of deposit in squares G2 and G3

Figure 7.8

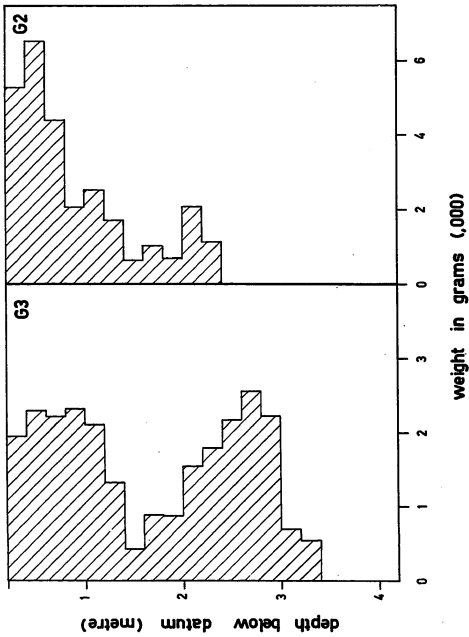


Figure 7.9 - Effluents

Weight of waste stone in each 20 cm.
of deposit in squares 04 and 05

Figure 7.9

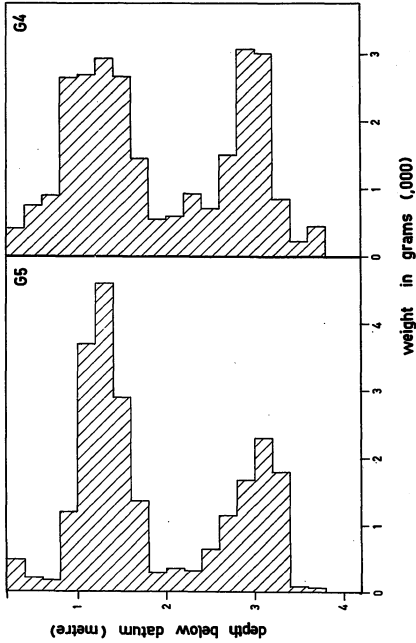
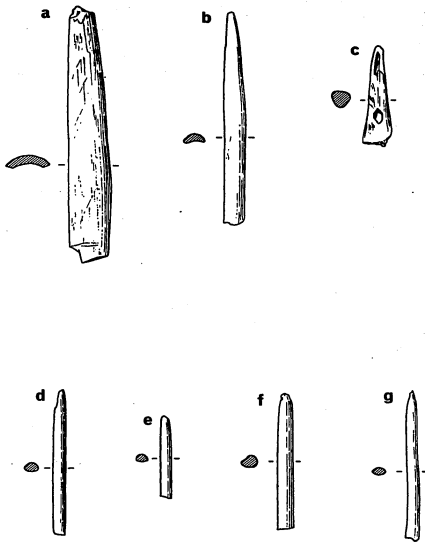


Figure 7.10 - Kafiavara

Scale 3:2

- a. Large spatulate bone point. G3/(18)
- b. Broad, flattish point, class 1. H2/(23)
- c. Pierced metapodial. H3/(33)
- d. Medium asymmetrical point, class 2. H2/(17)
- e. Medium asymmetrical point, class 2. G2/(10)
- f. Medium asymmetrical point, class 2. G2/(10)
- g. Thin fine point, class 3. H2/(15)



mw

Figure 7.11 - Kafiavara

Scale 1:1

- a. Pointed butt of axe-adze, flaked from river pebble.
135.H4/(50)
- b. Small, whole, partly-ground axe-adze. 14.F6/(4)

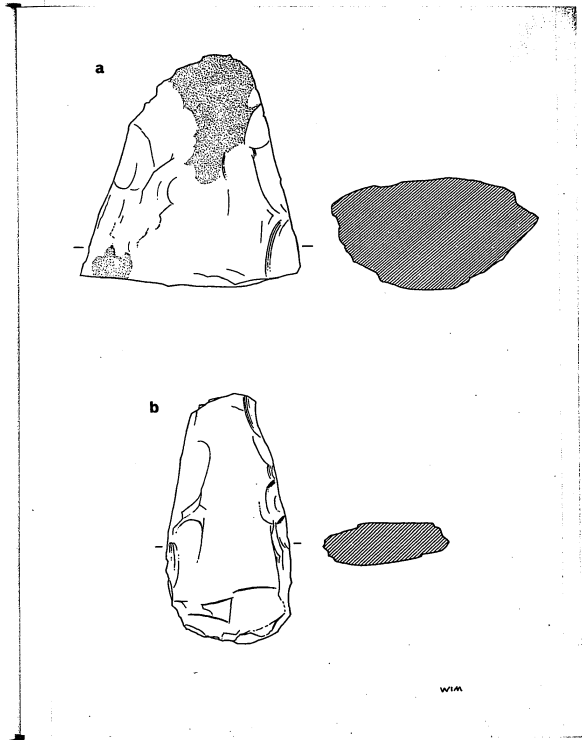
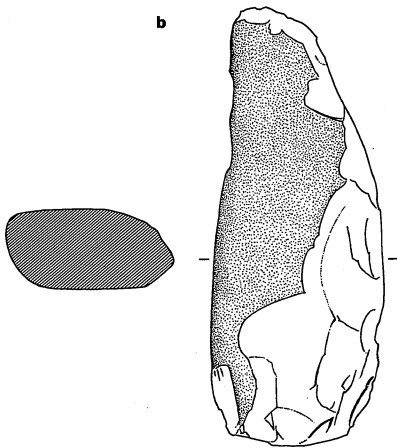
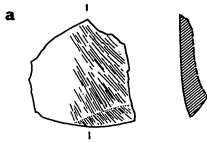


Figure 7.12 - Keflavik

Scale 1:1

- a. Chip off cutting edge of ground axe-adse. G4/(47)
- b. Axe-adse flaked from river pebble. F6/(1)

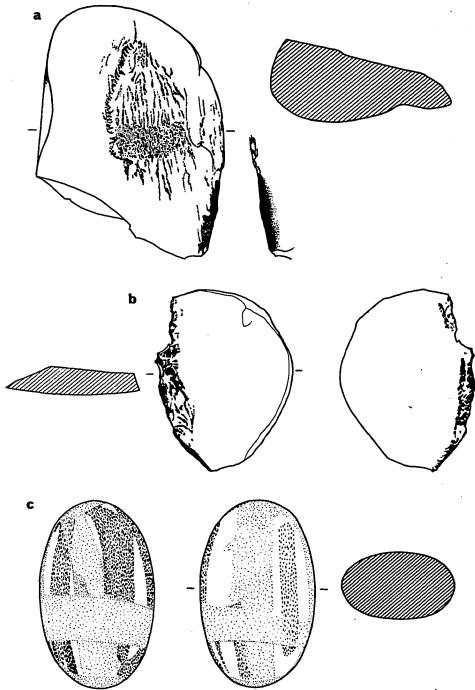


WMA

Figure 7.13 - Kafiavara

Scale 1:1

- a. Use-polished flake. Heavy polish (class 1) along one edge and slight polish on positive bulbar surface. 19.G5/(7)**
- b. Flake used for cutting ochre. 60.H4/(17)**
- c. Pebble painted with light and dark red ochre (light and dark shading respectively). 29.H2/(6)**

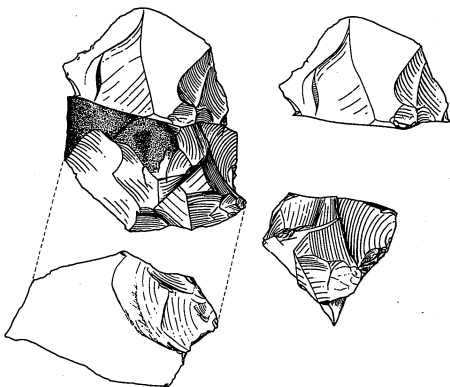


WIM

Figure 7.14 - Kafiavans

Scale 1:1

Multiplane scraper; two altered edges. The top part has been re-used after the tool was broken as is shown at top right (one altered edge). 44 and 45.F5/(26)

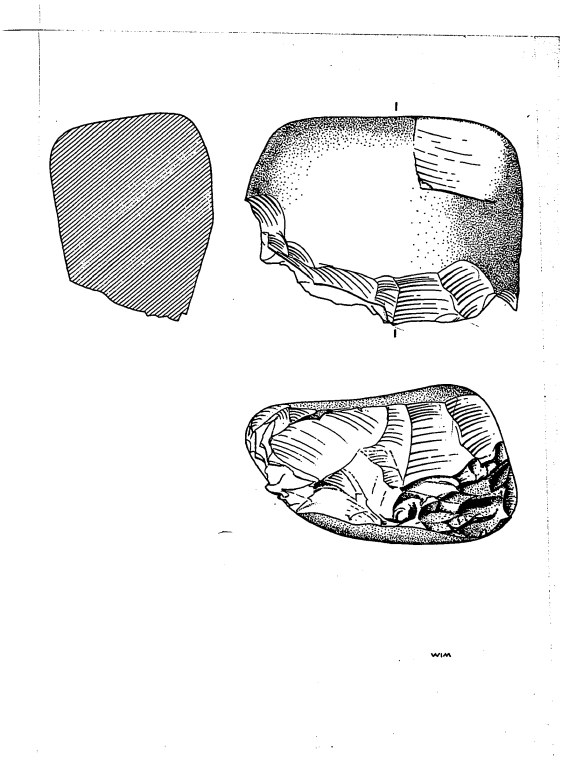


WIA

Figure 7.15 - Kafiavara

Scale 1:1

Pebble tool; unclear number of altered edges because of
concretions. 05/(34)

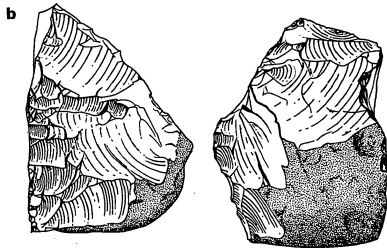
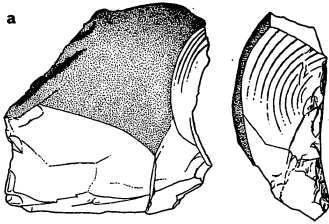


WIA

Figure 7.16 - Kafiavara

Scale 3:2

- a. Side scraper; four altered edges. 151.G3/(37)**
- b. Multiplane scraper; six altered edges. 155.G3/(38)**



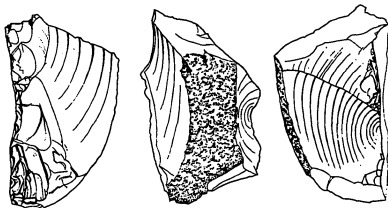
WIM

Figure 7.17 - Kafiavang

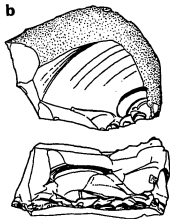
Scale 3:2

- a. Multiplane scraper; five altered edges. 150.03/(37)**
- b. Double end and side scraper; six altered edges.
134.04/(34)**
- c. Discoid scraper; five altered edges. 156.83/(33)**

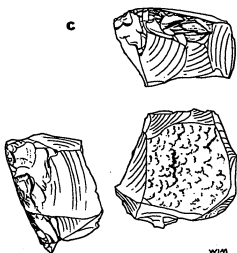
a



b



c

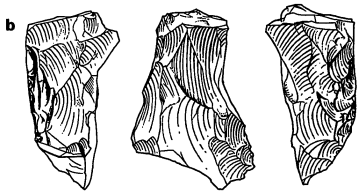
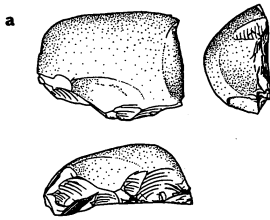


W111

Figure 7.18 - Keflavik

Scale 3:2

- a. Side and end scraper; two altered edges.
118.03/(27)
- b. Double side scraper; three altered edges.
110.24/(37)



www

Figure 7.19 - Kafiavans

- a. End scraper; two altered edges. 38.05/(12)
- b. Multipane scraper; two altered edges. 40.05/(9)
- c. Double side and end scraper; five altered edges. 151.04/(40)

Drawn: J.J. Dorstreich

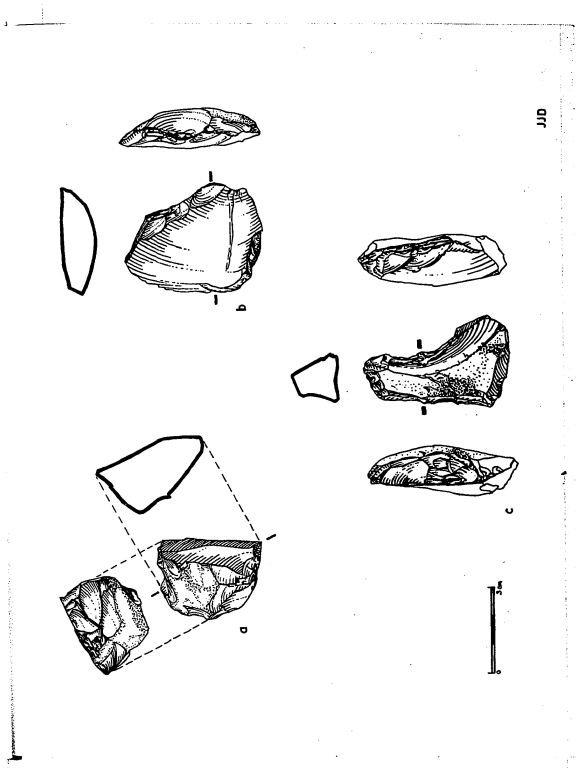
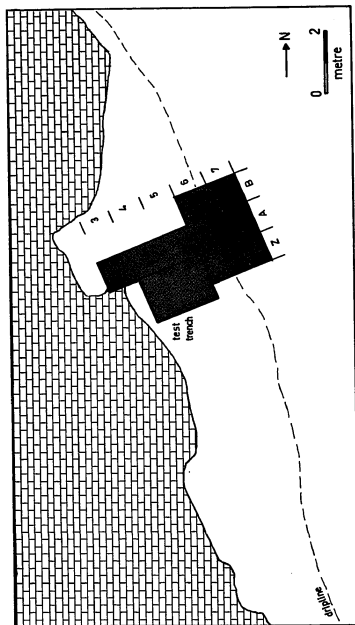


Figure 8.1



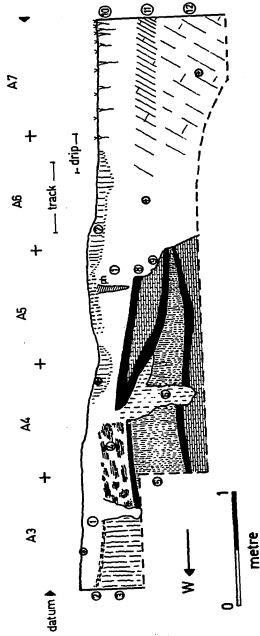
Niobe : plan.

Figure 8.2 - Niobe

Stratigraphy along north wall of main trench

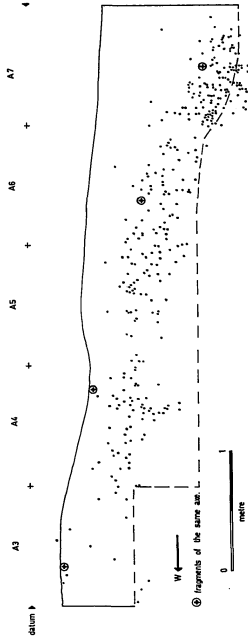
1. Grey silty sediment
 2. Fine ash and carbon
 3. Light brown silt slightly concreted
 4. Brown and cream silt, slightly concreted in patches
 5. Very hard fine sediment
 6. Very soft fine grey silt, similar to 1.
 7. Pit and tip disturbance
 8. Flowstone
 9. Stalagmite incorporating some soil and bone
 10. Wet dark grey humus with roots
 11. Orange-brown clayey humic sediment
 12. Brown, slightly clayey, sediment
- + Fragments of the same axe. See Figure 8.23

Figure 8.2



Niobe : north wall of main trench.

Figure 8.3



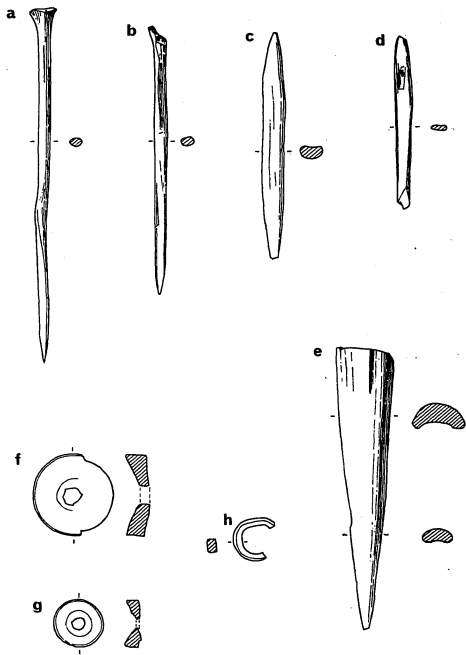
Niche : Implement scatter.

Implements from A3 - A7 plotted onto northern wall.

Figure 2.4 - Niche

Scale 1:1

- a. Bone awl. 98.A4/(4)
- b. Bone awl. A3/(3)
- c. Bone bipoint. 117.A4/(5)
- d. Rectangular splinter of bone with pierced hole.
D2.A3/(1)
- e. Broad, flat bone point. 453.26/(9)
- f. Fossil shark vertebra. 681.27/(15)
- g. Fossil shark vertebra. 27/(15)
- h. Segment of bone ring. A4/(3)

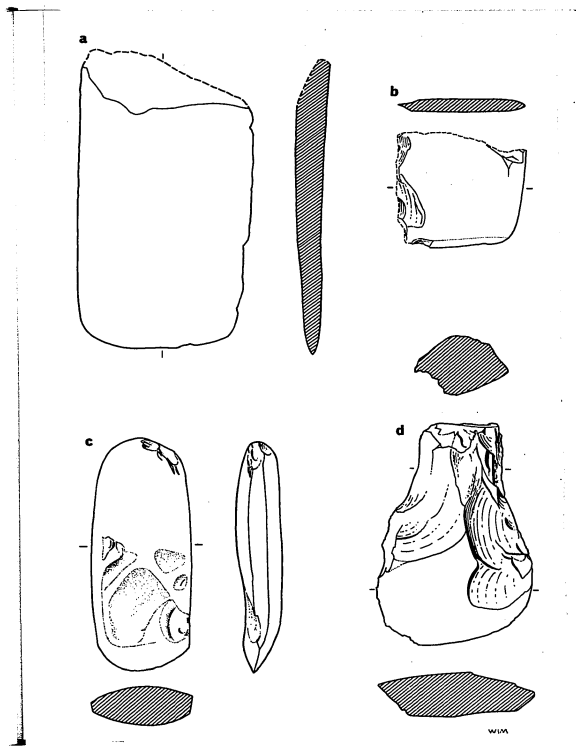


W.M.

Figure 8.5 - Niobe

Scale 1:1

- a. Fragment of thin, rectangular axe. 164.A6/(3)
- b. Fragment of thin, rectangular axe. No(2) - test trench
- c. Planilateral-sectioned, ground axe-adze. D4.A2/(1)
- d. Waisted blade, ground at the cutting edge. 224.A6/(9)

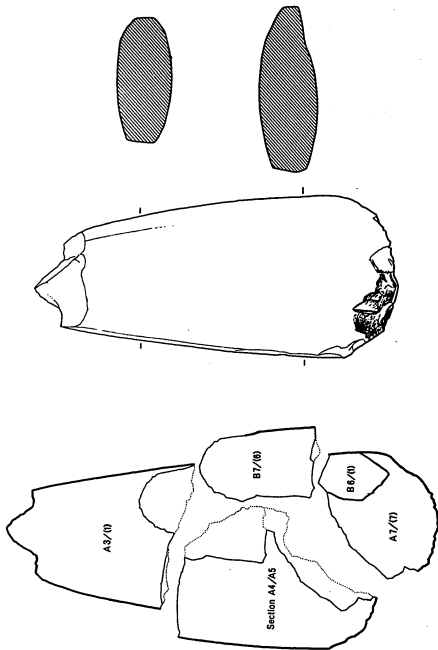


WIM

Figure 8.6 - Nisbe

Scale 1:1

Broken planilateral-sectioned ground axe-edge, showing location of the fragments in the excavation. Note truncated use-polish on the cutting edge.

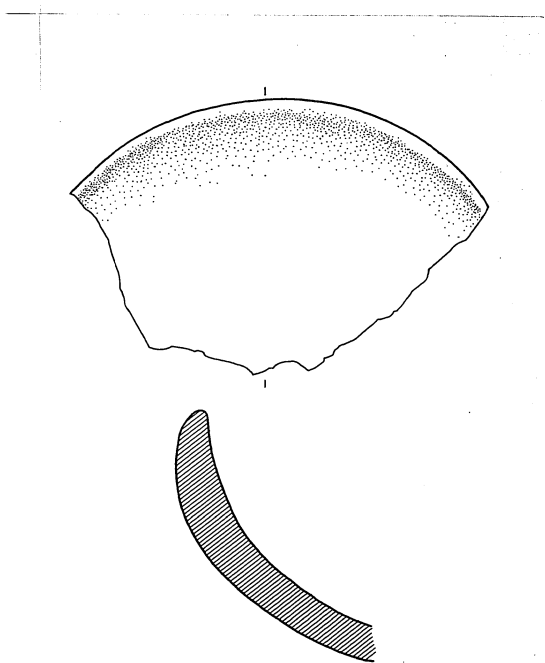


W/M

Figure 2.7 - Niche

Scale 1:1

Fragment of stone mortar. D5.A3/(4)

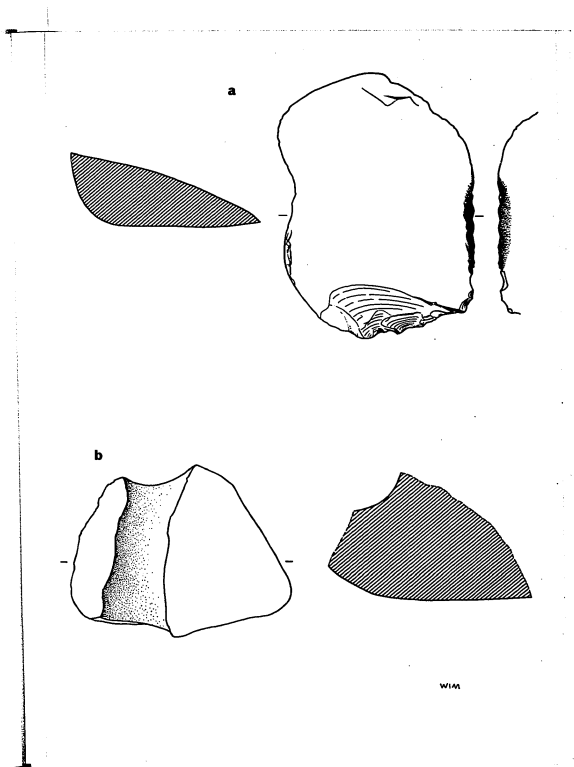


WIM

Figure 8.8 - Nibs

Scale 1:1

- a. Flake with bifacial use-polish, class 1. No(5)₃-
test trench
- b. Broken club-head? 350.B7/(5)

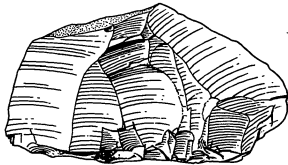
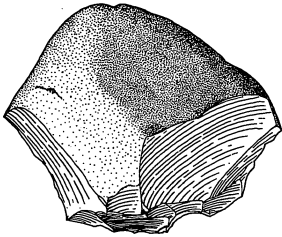


WIA

Figure 8.9 - Niobe

Scale 1:1

Pebble tool. No(8)₁ - test trench

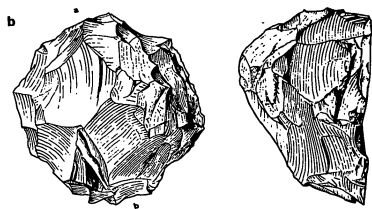
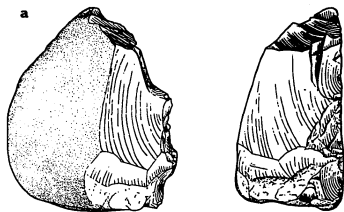


WIM

Figure 8.10 - Niobe

Scale 1:1

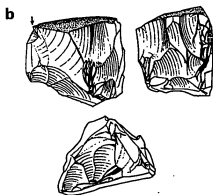
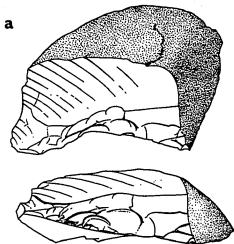
- a. Pebble tool. No.(7)₁ - test trench
- b. Pebble tool. No.(7)₁₄ - test trench



W144

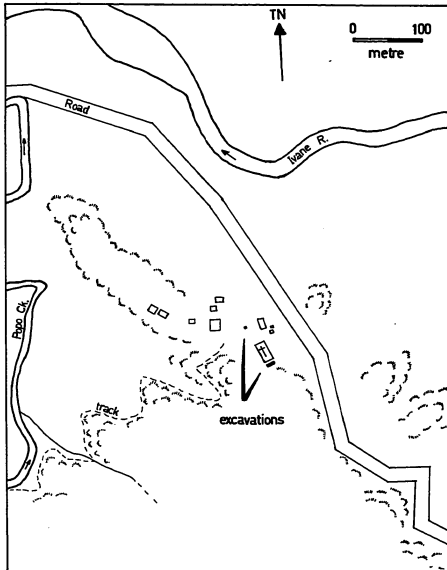
Figure 8.11 - Nieba
Scale 3:2

- a. Side scraper. 27/(8)₃
- b. Multiplane scraper. 361.A7/(6)



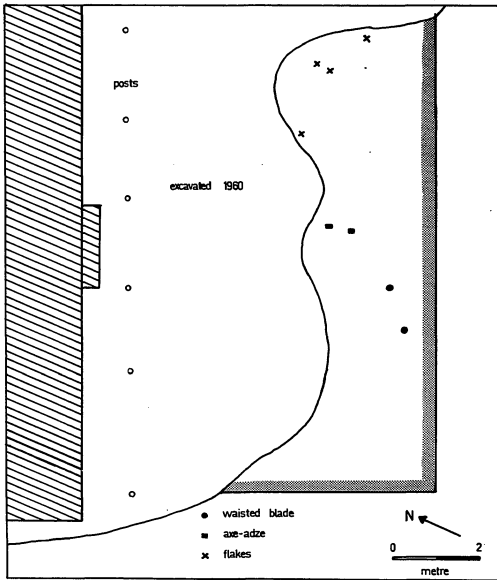
WIM.

Figure 10.1



Kosipe : sketch map

Figure 10.2



Kosipe : excavations south of church.

Figure 10.3

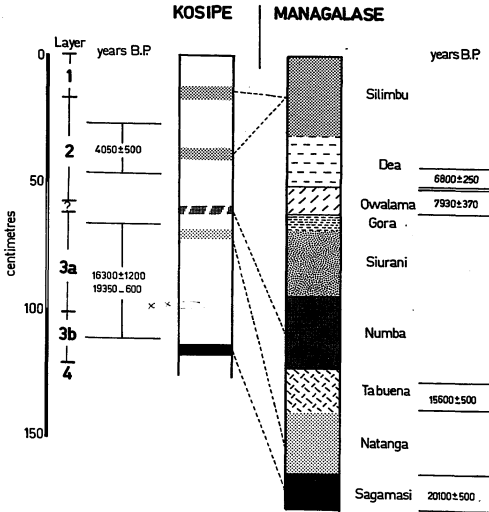


Figure 10.4 - Kosiya

Scale 1:2

- a. Stone mortar fragment (excavated 1960)
- b. Stone mortar (excavated 1960)

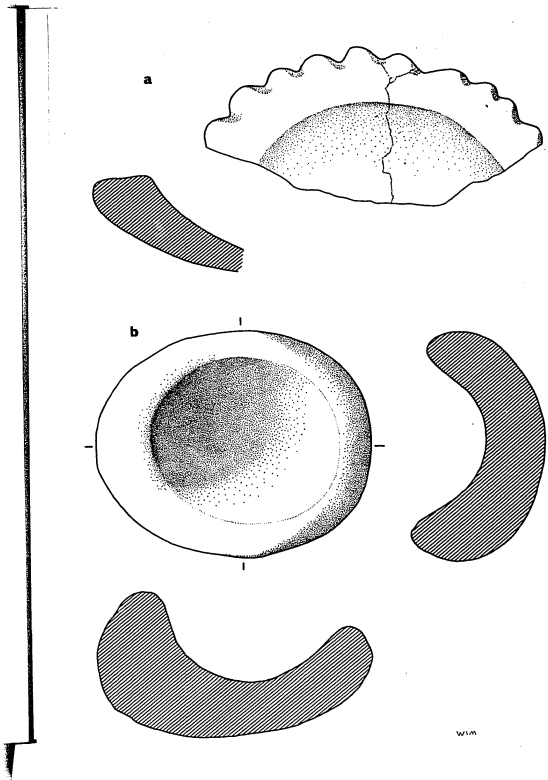


Figure 10.5 - Kosiya

Scale 1:2

- a. Waisted blade. II/(4)
- b. Waisted (shouldered) blade. IV(3)
- c. Waisted blade (excavated 1960)
- d. Butt fragment of axe-adze. IV/(3)-(4)
- e. Waisted blade, very weathered. II/(2)-(3)
- f. Partly ground axe-adze. Level (2). Collected
by K. Crook

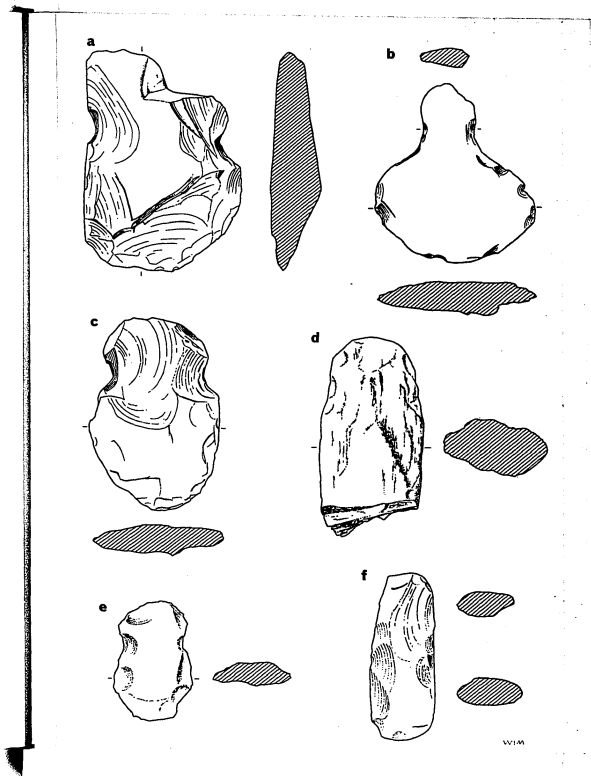


Figure 11.1

Depth (m) Level	Cl- Years	Axe - adze Laminar Pneumatic Tool	Neolithic Blade	Polished Blade	Polished Blade	Polished Blade	Utilised	Blade Horizontal hole	Blade Horizontal hole	Pine tool	Blade Blade	PS	CS	Polymer Site phase
0														
1														
2A														A
2B														
	4840 ± 140													
3														
4														B
5														
6														
7														
8														
9														
10A														
10B														C
11														
12														
13														
14														
Total		6	3	16	4	47	3	168	200	1211	10	3	?	1

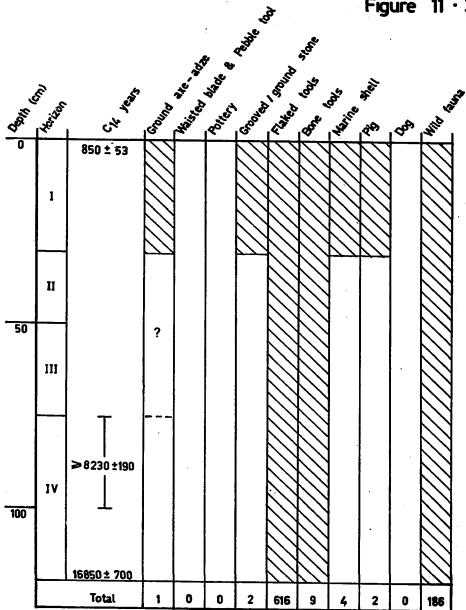
Kiowa : excavated artefacts . (after S. Bulmer 1966)

Figure 11.2

Depth (ft)	Level	C/A pieces	Unifacial	Triangular	Total	Whetted blade	Flake tool	Pointy	Utilised flakes	Rebashed tools	Waste flakes	Bone tools	Wooden tools	Native shell	Pig	Dog	Site phase
0	1								3	-	22						
	2			1	1				2	14	51	1	3	1			C
2	3		1		2	4	2		40	58	428	2			2		B
	4					11	2		16	29	206	4					
4	4																
6	5					4			-	1	23	1	1				A ²
8	6								1								unoccupied
10	7					2	1		8	8	17						A ¹
	Crevise					2	3		4	6	40						B
	Total	1	1	3	23	8	0	2	116	786	8	4	4	4	?	0	

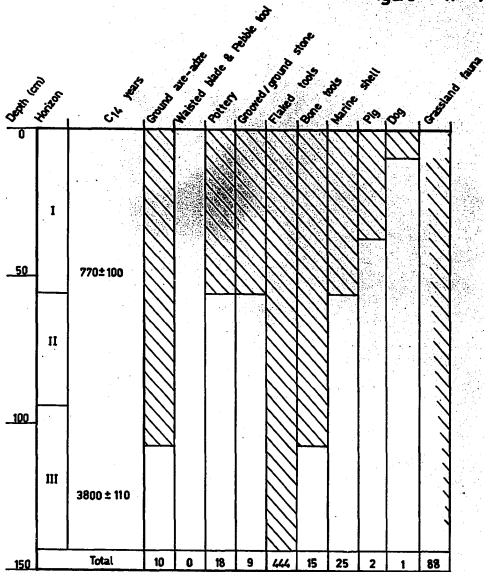
Yuku : excavated artefacts (after S. Bulmer 1966.)

Figure 11 · 3



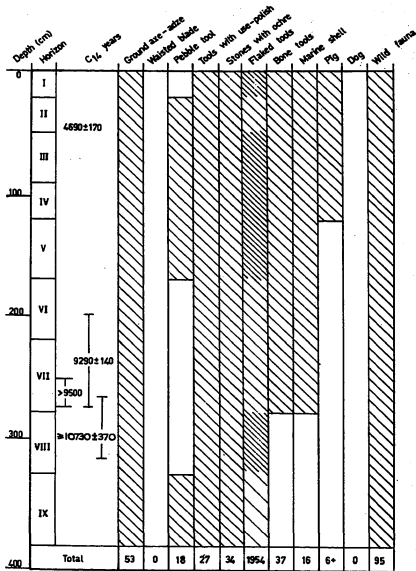
Batari : excavated artefacts.

Figure 11.4



Aibura : excavated artefacts.

Figure 11-5



Kafiavana : excavated artefacts.



Plate 2 - 1 Rock engravings at Wakuia Wai,
Central District, Papua.



Plate 2 - 2 Composite photo of engravings at
Wakuia Wai, Central District.



Plate 3 - 1 Obsidian head of sago pounder collected
at Lake Kutubu. Slightly over natural
size.



Plate 3 - 2 Head of sago pounder. Note use -
polish on the edges of step-flakes.



Plate 4 - 1 Boys breaking open chert boulders on a gravel bank of the Fayantina River.



Plate 4 - 2. Flaking a chert pebble, using a river pebble as a hammer. Legaiyu.



Plate 4 - 3. Flaking a chert pebble. Legaiyu.



Plate 4 - 4. Tounamo flaking a chert pebble during the program of experimental flaking. Legaiyu.



Plate 4 - 5 One edge of a flake is blunted to make it more comfortable to hold during use. Legaiyu.



Plate 4 - 6. Tounamo using a stone axe to chop a billet of black palm into the correct shape for a bow. Legaiyu.



Plate 4 - 7. Demonstrating the cutting action of a stone axe. Legaiyu.



Plate 4 - 8. Tounamo planing a bow with a stone plane. Legaiyu.

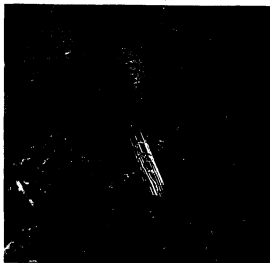


Plate 4 - 9. Stone plane in use near the nock of a bow.
Legaiyu.

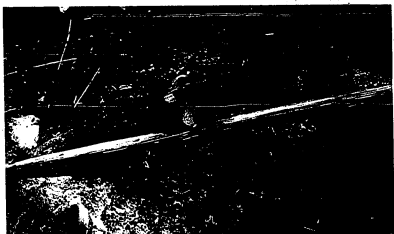


Plate 4 - 10. Plane at about the end of a stroke. Legaiyu.



**Plate 4 - 11. Scraper-plane at about the end of a stroke.
Legaiyu.**



Plate 4 - 12. Stone knife cutting grooves for a bow nock.
Legaiyu.

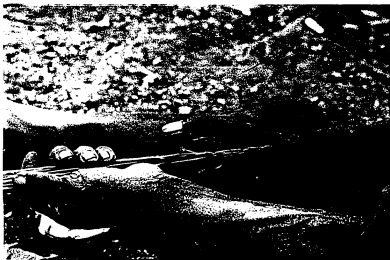


Plate 4 - 13. Scraping a bow nock. Legaiyu.



Plate 4 - 14. Stone knife cutting barbs on an arrow. Legaiyu.



Plate 4 - 15. Bamboo knife cutting barbs on an arrow. Legaiyu.



Plate 4 - 16. Pig fibula awl used during the binding of a bamboo arrowhead to its shaft. Legaiyu.



Plate 4 - 17. Pig fibula awl being sharpened on a whetstone. Legaiyu.



Plate 4 - 18. Drilling out an arrowshaft by rotating it on a sliver of bamboo. Legaiyu.



Plate 4 - 19. Red ochre being painted on a barbed arrowhead using a pared twig as a brush. Legaiyu.



Plate 4 - 20 Use-wear on tool used for cutting-scraping a bow nock, the tool being jarred against the nock at the end of each stroke. Length of wear 2.0 cm. Legaiyu.

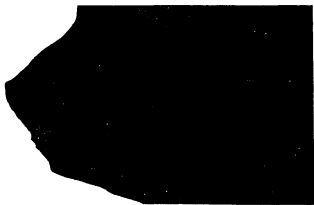


Plate 4 - 21 Use-wear on an edge held vertically on wood (arrowed side towards the user) and drawn towards the body. Length of wear 1.4 cm. Legaiyu.



Plate 4 - 22 Part of one side of a thin edge used as a saw-knife.
Direction of motion while in use indicated by arrow.
Arrow 0.5 cm. long. Legaiyu.



Plate 4 - 23 The same saw-knife edge photographed end-on.



Plate 5 - 1. Country surrounding Batari. The natural limestone bridge containing the cave lies at the foot of the spur in the foreground.



Plate 5 - 2. Eastern side of the natural limestone bridge, showing the present river at the foot.

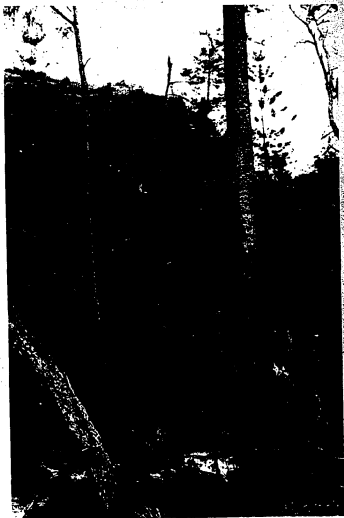


Plate 5 - 3. Batari: the site is halfway up the limestone bridge, above the present river.

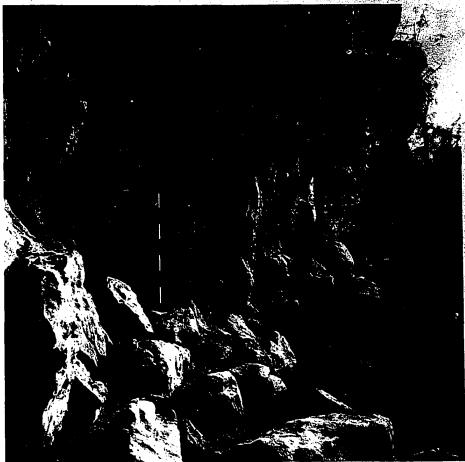


Plate 5 - 4. Batari: entrance, with stalagmitic wall on right. Scale in 20cm.



Plate 5 - 5. Batari: south part of the cave prior to excavation. Scale in 20cm.

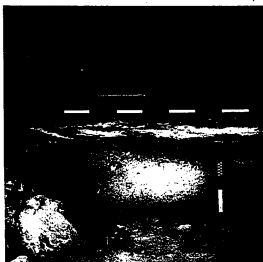


Plate 5 - 6. Batari: west face of squares D3 and D4.
Horizontal scale in 20 cm.

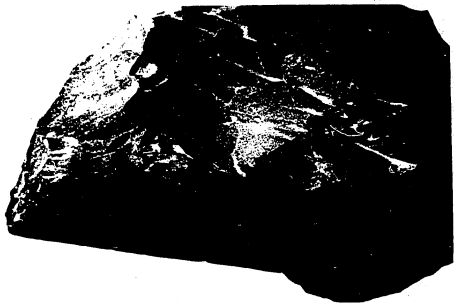


Plate 5 - 7 Altered edges of implement F3/33
(also drawn).



Plate 5 - 8 Implement D3/62 (also drawn).



Plate 5 - 9 Altered edge of implement D3/62.



Plate 6 - 1. Aibura and surrounding country, viewed from north.



**Plate 6 - 2. Bush-covered limestone outcrop containing
Aibura cave, viewed from north.**



Plate 6 - 3. Aibura: main chamber prior to excavation, looking north. Scale in 20 cm.



Plate 6 - 4. Aibura: concentration of limestone boulders in I/(3). Scale in 20 cm.



Plate 6 - 5 Aibura: excavation to base of level 3,
showing boulders, postholes and pit.
Scale in 20 cm.

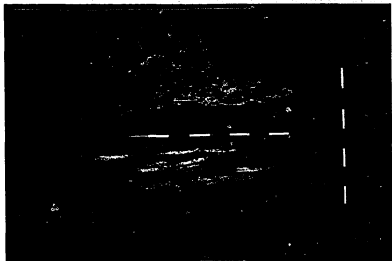


Plate 6 - 6. Aibura; northern 3 m. of section AB, and part of section BC, showing ash lenses overlying black silt, with sterile material at base. Scale in 20 cm.

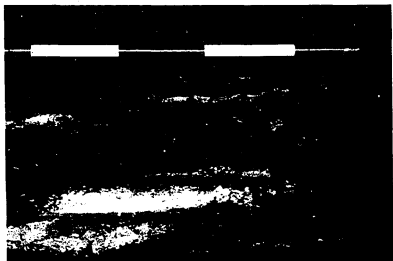


Plate 6 - 7. Aibura; northern 80 cm. of section AB, showing postholes. Scale in 20 cm.

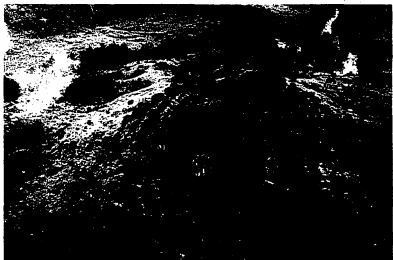


Plate 7 - 1. Kafiavana: aerial view of Koyagu hill from southeast. Shelter is at junction of arrows.

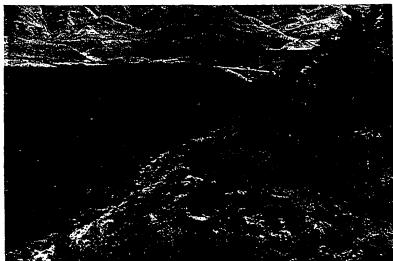


Plate 7 - 2. Kafiavana: shelter is behind clump of bamboos in centre of picture.

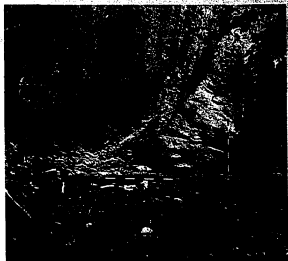


Plate 7 - 3. Kafiavana shelter before excavation, viewed from the western end. Scale in 20 cm.

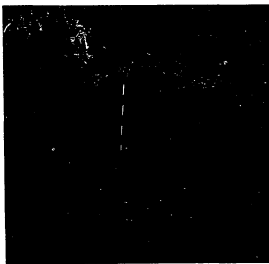


Plate 7 - 4. Kafiavana: excavation partly completed. Ranging pole stands at northwest corner of square H3. Scale in 20 cm.



**Plate 7 - 5. Kafiavana: excavation partly complete,
exposing part of the natural clay wall in
squares F3 and G2. Scale in 20 cm.**



**Plate 7 - 6. Kafiavara: east wall of completed excavation
(F3 - F5), showing natural clay wall at left.
Scale in 20 cm.**

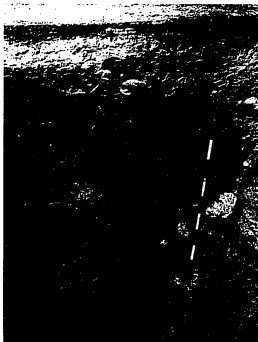


Plate 7 - 7. Nafiavana: west wall of completed excavation (H2 - H4). Pole rests on clay wall which has been cut into at lower right. The top of the damp deposit can be seen just above the pole. Scale in 20 cm.

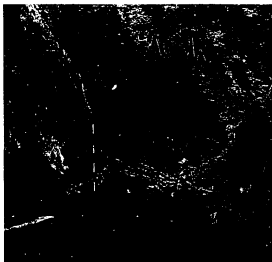


Plate 7 - 8. Kafiavana: excavation in relation to rear wall of shelter. The location of the latex section (white) and soil column samples on the west wall of H2 - H4 is also shown. Scale in 20 cm.

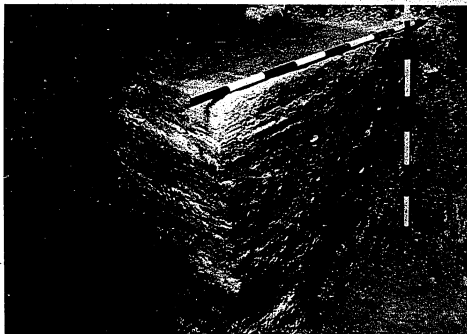


Plate 7 - 9 Kafiavana: west wall of squares G2 - G3 showing horizontal strata above sloping strata. The horizontal surface is 200 cm. below datum.



Plate 8 - 1. Niobe; general view of shelter. Excavation was made in left foreground. Scale in 20cm.



Plate 8 - 2. Niobe; squares A4 - A5 showing cracked flowstone and areas of concreted soil.



Plate 9 - 1. Aibura; painter at work.



Plate 9 - 2. Aibura; painter with almost completed design.



Plate 9 - 3. Aiburas paintings. The same human figure is seen in both pictures.
Scale in inches.

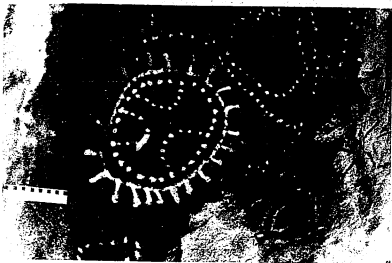


Plate 9 - 4 (both). Aibura: paintings. Scale in inches.

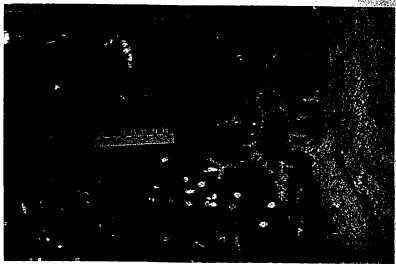




Plate 9 - 7. Kafiavana; painting no. 23.
Height 52 cm.

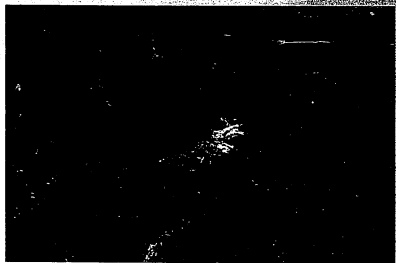
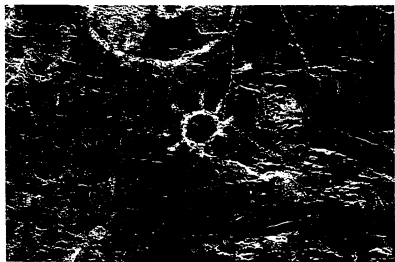


Plate 9 - 8. Kafiavana; painting no. 48. Length 30 cm.



**Plate 9 - 9. Kafiavana; paintings (l. to r.), top, nos. 31 and 32; centre, nos. 34, 35, 44; bottom, no. 36.
Radius of no. 35, 17 cm.**



Plate 9 - 10. Kafiavana: painting no.40. Width 20 cm.

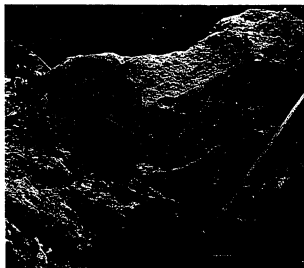


Plate 9 - 11. Kedawa'aipa: engraving no.3.



Plate 9 - 12. Niobe: painting no. 6. Scale in inches.

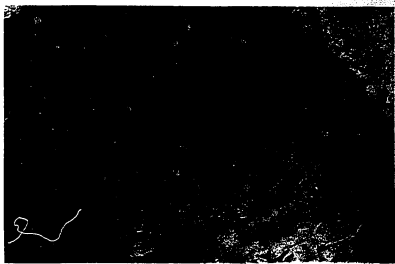


Plate 9 - 13. Niobe: paintings (l. to r.), top, nos. 12 and 28;
lower, nos. 30 and 29. Scale in inches.



Plate 10 - 1. Kosipe: Mission viewed from north-west. The church is the large building in the background.

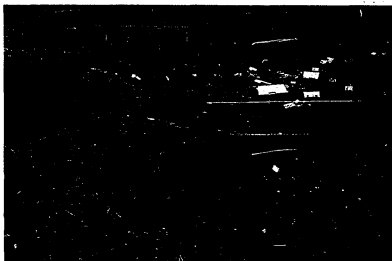


Plate 10 - 2. Kosipe: aerial view of Mission from east.

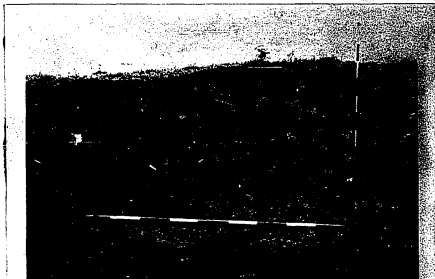


Plate 10 - 3. Kosipe: stratigraphy of excavation at south end of the church. Scale in 20 cm.



Plate 10 - 4. Kosipe: stratigraphy of excavation at north end of the church. Scale in 20 cm.